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LIEUTENANT-GENERAL E. H. CLIVE in the Chair.

SOME METHODS OF EXECUTING INFANTRY FIRE ON THE BATTLEFIELD.

By Captain C. B. MAYNE, R.E.

GENERAL CLIVE AND GENTLEMEN, many of us think that there is no formation for attack laid down in the Drill Book. A standard form for attack is certainly forbidden by the Drill Book; but whether that means the formation adopted for attack, or whether it means the mechanism of the attack, it is a little hard to say; but directly we come to read different pages of the Drill Book, we find that we are there told the relative proportions of the different parts into which a battalion is to be divided. Thus we find laid down the relative proportions of the firing line, supports, and battalion reserves, viz., "at the outset the strength of the supports and firing line should be about the same, and that the men of any unit in the firing line should be supported by men of the same unit." We are also told that the strength of the battalion reserve is to be equal to the strength of those two lines together. In that way we at once flash into a normal battle formation. We are to have one-fourth of the battalion in the firing line, one-fourth as supports, and one-half as battalion reserves. Further on we are told the distances that are to be left between these successive echelons, and we are also told the maximum and minimum frontages.

I shall suppose that Fig. 2 represents the authorised battalion formation. I am now going to offer some views of my own as to how to further carry out the attack when we have once been formed up for attack as shown in Fig. 2. Before, however, venturing to

express my views on this subject, I must ask you to consider for a moment my view of what a battle essentially is. To me the organized, trained, and disciplined collection of individuals, known as an army, represents a certain quantity of moral and mental, as well as of material, force. And I would define a battle as a contest between the variable moral, mental, and material forces possessed by two opposing hostile bodies of men, each of whom is more or less working in the dark, and each of whom is trying to wear down and destroy the moral, mental, and material forces of its opponent while trying to conserve its own similar forces. This is more than our ordinary text books teach, for they seem to be based on the idea of two material forces hammering at one another. But there are other important forces at work as well, especially of a mental and moral nature, which must be considered. The mental forces vary very slowly during a campaign, but the moral and material forces vary constantly, often very considerably, from day to day, and both of these must be fully considered by the G.O.C.

In the destructive effort, already mentioned, the moral, mental, and material forces of both sides suffer. In my own studies I lay the very greatest stress in keeping this view of battle clearly before myself. But, in its practical execution, a battle is, generally speaking, composed of two great acts, viz., (1) the *destructive or preparatory* act, and (2) the *decisive* act. These two acts are called, in the Drill Book, *the attack* and *the assault*, respectively. The destructive act, or the attack, begins the fight and often lasts some hours. During its execution each side is trying to destroy by fire the moral forces and organization of the other side in order to ensure a successful issue in the final decisive act, or the assault. *The destructive act* is carried out by a more or less thin line of men and guns spread out along the front of the enemy. This long, thin line moves slowly forward, suffering and inflicting losses. It sways backwards and forwards, according to the losses it suffers or reinforcements it receives. As the enemy is approached command gets more and more difficult and disorder increases until, finally, the enemy is approached near enough to force on a decision. *The decisive act* is, unlike the long destructive act, of short duration. In the face of the efficacy of modern fire-arms it is only attempted as soon as the preparatory act has sufficiently paved the way for its successful accomplishment. It is carried out by a more or less compact and deep body of men, advancing on a relatively narrow front, who try and break through the enemy's front with their bayonets at some point which, if captured, will compel him to retreat, or will facilitate his destruction.

Thus it is easily seen that the conditions under which the two acts —the attack and the assault—are made are totally different. *The attack* is a long-drawn-out operation, exhausting to the men taking part in it, and tending to confusion and loss of control. *The assault* is a short, quick operation, and requires for its best execution troops which are not only fresh, but which have not suffered any severe moral or material loss.

What I am going to address you upon to-day deals almost entirely

with the preparatory period up to the time of the assault. The preparatory period is really a period of fire—of artillery fire principally at the beginning, aided subsequently by infantry fire. Our brother officers of the artillery have for many years past been studying very hard the question of how to improve the efficacy of artillery fire, and they have had many opportunities given them, which the infantry have not had, of practically ascertaining the best methods of carrying out artillery fire.

At Okehampton and other places they have had ample means of deliberately finding out what are the best means of carrying out artillery fire by batteries and brigade divisions, in order to secure the maximum result possible with the ammunition available on the battlefield. With regard to infantry fire, no such privileges or opportunities have been accorded, and it seems a great pity that infantry have not also centres of practical instruction and experiment which they can annually visit, just as the artillery batteries visit their centres of instruction, in which to practise and experiment on the best ways of conducting infantry fire under battle conditions, so as to see which are the best methods for securing the highest percentage of hits; for in that way alone can we test the various theories which have been put forward for these so-called methods of carrying out the attack.

I will put one forward this afternoon which I think is feasible, and I have based it very largely on the annual reports on the field firing conducted in India, which have been very kindly sent me by the Adjutant-General for Musketry there. These reports contain a very large number of actual field-firing experiments which were carried out with real powder and shot at, of course, targets; but they have all the conditions which we can possibly show in peace-time, that obtain in time of war, that is, the noise and confusion which are attendant on firing and on advancing over rough ground, excepting the disturbing effect of the enemy's bullets. Anyhow, in this way in India they carry out experiments, and are thus able to see which are the best methods by which the highest percentage of hits can be obtained, and in that way alone should the various proposals put forward be tested.

Naturally, in battle, during the opening period of preparation, the methods of conducting infantry fire must be very important, and I think we have to look to the artillery, which is essentially the arm of fire, to learn from them how we should in many respects conduct infantry fire; just as we should look to the cavalry as to how we should conduct the "assault" or the "shock" which decides the battle at the end; because, although many of you know how much I have written on infantry fire, I am one of those who, personally, believe that the battle is to be decided at the bayonet point, or by the threat of it anyhow. An old instructor of mine used to use the expression that two boys may throw stones at one another all day long, but in order to make the other boy run you have to go at him with your fists as well; and it is the same with infantry on the battlefield.

Uncontrolled fire is out of the question. We do not want to practise it; it will come in of its own accord in time, so that I can only deal with the question of controlled fire. We only have two forms, "volley firing" and—what is an awkward term, but it is one which I have adopted from Continental writers—"mass firing,"[1] which is really controlled individual firing, controlled either by limiting the number of rounds the men are to fire or by training them carefully to stop at the sound of the whistle, while the firing is being conducted in such a way that careful observation can be kept on the men to see that they are using their sights for the proper range, and also are aiming at the objective that has been ordered.

We all know that volleys have a great moral value. Past experiments have shown that mass firing has given rather higher percentages on targets than volley firing. On the other hand, volley firing has undoubtedly the very great advantage of keeping the men in hand. Its moral effects are so great that, as in a battle we have to consider both moral and material conditions, volley fire, in my opinion, should be kept up as long as possible without unduly straining the men's attention; for I believe that if you try to restrain their natural instincts too long a reaction will come, and they will get still more out of hand than if you had allowed them to act on what nature requires at the proper time instead of forcing their instincts into unnatural channels. Anyhow, volley firing for the larger portion of the early part of the fight is, I think, very necessary on account of the moral effect and control it gives you over the men, and, of course, for preserving from waste your ammunition, which will be so valuable towards the end of the action.

Then, again, there is the danger of mass firing degenerating into uncontrolled independent firing if taken up too soon, and therefore it is better to maintain the mass fire for such ranges that if it does degenerate into independent fire some useful effect may be expected from it, provided the men have been trained, as they are being trained largely nowadays, to aim low with fixed sights, and thus we hope that the "second nature" so acquired will help them in action in that direction. But we have to remember that volleys can only be maintained so long as organized units are maintained. As soon as organized units can no longer be maintained there is very little chance of being able to carry out volleys, and it is on this subject that I am going to offer suggestions this afternoon. That is, I am going to offer suggestions which I think may be of value upon this principle of maintaining some kind of organized units during the action as long as possible.

But, before proceeding further, we have other things to consider in the attack formation, viz., the question of reinforcing. We know that losses occur, and the energy and courage that men have will in time ooze out. Consequently they will, after a time, come to a standstill, and then before the firing line can be moved on again a fresh body of men, which has not been so much affected by such demoralizing influences, has to be sent forward in order to propel the line on

[1] See p. 1039 for definition of the term "mass firing," as here intended.

again. This may have to occur several times, and therefore we have to consider this question—What is to be our reinforcing unit? It must be of such a size as will be adequate to carry on the exhausted portion of the firing line, exhausted probably both in its moral qualities and in its physical powers. I am supposing companies to be 100 strong, and that the battalion consists of 800 men. Then the section of about 25 men ought to be the very minimum size for the reinforcing unit that should be used. There is still another point which most of you will, I think, concede, that is, that as you get nearer the enemy the strain on the men, both morally and materially, becomes much greater, and therefore the reinforcing unit may have to be increased in size in order to impel the firing line on further if it gets stopped in any way, and therefore the reinforcing unit, if we begin with a section, must be capable of being increased in size, if occasion demands, as we approach the enemy.

If, after a time, the battalion is unable to advance as a whole, then comes the question of what is to be the advancing unit. I will take an extreme case. It was stated in the old Drill Books that the men in the firing line were to advance by alternate files and fire. At once the men left behind have to cease firing, because it would be utterly impossible for them to fire accurately through the intervals of one or two paces between the men in front. It simply means that while the leading men are advancing the fire of the others has to cease. Again, if the battalion advances in alternate sections it leaves but small gaps, say 50 yards at the outside, through which the men left behind have to fire. Besides this, several of the men left behind on either side of the gap must also cease firing, because they would not be able to fire so accurately as just to miss the men in advance on their right or left. It therefore means the ceasing fire of a number of rifles in addition to those of the advancing men. I am therefore an advocate of advancing as large a unit as possible. To advance the whole battalion as a single unit would be perhaps rather awkward, so that if you have to advance by alternate rushes I advocate an advance by alternate half battalions for the reasons I have stated.

Now, coming to the application or carrying out of these suggestions, let us take the case of an eight company battalion. These eight companies would be first drawn up in their "assembly" formation of line of half battalions, each in quarter column, previous to entering into action. The officer commanding the battalion would then allot to the companies of each half battalion their different positions and duties. Then I would suggest that these companies should be marched up to these positions at once before extending or doing anything else, because, in the majority of cases, it will not be necessary to extend them at once. They will, as a rule, be able to get up, under cover, to less than 1,000 yds. in such closed formations as company columns of sections or half companies; but, taking the case of open ground, we are supposed to begin at, say, 3,000 yds. from the enemy. It would even then be unnecessary to extend in open order at that distance, consequently I would advocate the company columns advancing, anyhow for some distance, in their relative

positions, until the enemy's fire is likely to become so serious as to make even these targets too large to advance with without suffering serious losses.

Then the next step would be this:—The sections of the leading companies would separate, and soon after comes the question of extension. The more men you extend, the more likely the men are to get out of hand, and the great thing at the longer ranges at which infantry fire is not efficacious is to extend as few men as possible at a time; then the question comes—to what extent? If you extend the men too far over the whole front you will probably get them so far extended that you will have very little control over them. At the longer range I do not think there would be any necessity to cover the whole front with a strong firing line, but you might extend the two leading sections of each of the four leading companies to two paces between the men. This should be the maximum extension, and it will cover the whole front of the battalion. When the time came for real, earnest infantry fire, then the other sections of each of the leading companies would be brought up into the firing line, giving one man to every pace, which is pretty well the sign that the real work of infantry fire is about to begin. The firing line is now organized into eight half-company units.

Now comes the method of maintaining these definite divisions, and we may learn from the artillery how to conduct the fire in the best way. Here we have in the battalion eight fire units, each composed of a half company, and each covering probably 40 to 50 yds. If we begin with volley firing it will be as much as the officer can do to command such a front with regard to volley firing, and in these definite half company fronts he has four subsections, with their recognised leaders, to look after the men to see that the men are carrying out the proper orders with regard to rapidity of fire, elevation, and the object to be aimed at and so on. Each company would have two fire units, and I would propose to call them the "right fire unit" and the "left fire unit" respectively, because these units will no longer be definite half companies after a little while, and it would not be advisable to keep constantly changing the name of the unit all the way through the attack. I do not think there will be any confusion between the two fire units of each company in the firing line, because the one will be "right" and the other will be "left," and the men in a "left" fire unit, hearing the word "right fire unit," would know that the order did not apply to them. The command would be "right fire unit," or "left fire unit," with regard to volley firing.

We know with regard to artillery fire, when a battery has to open fire, each gun does not go firing away as it pleases, but they begin to fire in succession from right or left, according to the battery commander's orders, and they fire gun by gun, and then they begin again in succession. I would propose the same method, either by battalion or by half battalions, of firing in succession from the right or the left of the battalion or of the half battalion respectively by these fire units. My reason for suggesting this is an army order which was issued in India in 1888, in which it says, "The concentration of fire by a

particular group or section on a particular object is only a step in the right direction, being but one degree removed from uncontrolled fire." Even sections firing volleys indiscriminately makes an uncontrolled fire for the time being. It gives the battalion commander very little hold over the firing line of his battalion if each section is allowed to fire whenever it pleased. The order then went on to say, "It is the direction of fire on one portion of the position undertaken by widely separated units which constitutes the true essential of concentrated fire," and I think, especially in these days when there is so much uncertainty as to where danger may crop up at any moment, it would be a tremendous power in the hands of any officer commanding an infantry battalion to be able to direct the whole of the fire of his battalion right or left as he pleases on any given objective, and I cannot see any way of doing that except by adopting the method found so advantageous in the case of artillery, of using the proposed fire units in the firing line as guns, and then, just as the gunners use their guns, to let them fire in succession from the right or left of the whole battalion or of each half battalion. One great advantage of such a system would be that you will have only eight voices in the firing line, and, further, as you could not expect the senior officer with each company in the firing line to do much more in the strain of battle than to direct his attention to the front, the battalion commander would have the duty placed on him of looking out right and left to advise each of his eight fire units as to the direction required for the fire, or even to watch the effects of the firing, because when the volleys are delivered one after the other there is some chance of watching the effects of the firing to see which volleys are under-sighted and which are over-sighted.

Now comes the question of reinforcement. I have spoken of the evil of early extension and the necessity of trying to avoid it as much as possible, and of forming a strong fire line only when a real efficacious fire effect is beginning to be wanted. When the first reinforcements come up, *i.e.*, the sections in support, they will move straight into the firing line without any closing taking place. Even if they overlapped to some extent, there would be some officer or non-commissioned officer who would mark the right or left of the reinforced fire unit, which would still be the fire unit to be made use of for fire purposes, however the men come in. In fact, whatever number of men were sent forward to reinforce a definite fire unit, it would still be the fire unit, although they would be stronger than half companies. The fire units are at first sections and then half companies, and you will find in the reports of the Indian field firing that they often speak of volley firing beginning with sections, which later develop into half-company, and then to company, volleys. This is simply due to the reinforcement units arriving into the firing line. As soon as two sections come together, the volleys become half-company volleys; it was really the volley of the fire unit, irrespective of the number of men in it. Consequently, I should measure the fire unit not by the number of men in it, but by the frontage it takes up. In that way, I think, volley firing would be kept up in a

reasonable way to a very much later period in the fight than can be done at present under true battle conditions. We have to remember that this closing to a flank in the firing line to admit of reinforcements coming up is almost impossible to carry out under fire. We see it done in drill, but I fancy that, under a heavy fire, any attempt to get the men deliberately to close to the right or left will be impracticable. It is best to recognise this fact and to make arrangements by which you may still maintain your fire unit, whatever number of men are in it, and to consider your fire unit to be measured by a given frontage, and not by the number of men or sub-units composing it.

In the same way as the reinforcing goes on, the sections of the reserve companies arrive in the firing line, and eventually even whole half-company units may be sent forward. We may assume that as soon as the supports are absorbed, we shall then be coming pretty near the enemy's position, and the moral effect of his presence will be greater. The men will have already moved over a considerable space of ground, and will become physically and morally exhausted. The reinforcements would thus have to be larger than sections, and now you can throw half companies in single rank into the fire unit fronts. Of course, in illustrating theoretical principles, one has to be a little mechanical in the drawing of the figures, and therefore the figures given will not exactly represent the state of things. When you come close to the enemy, the reinforcing would probably be by half companies, for the reinforcing units must be stronger than sections in order to carry that physical and moral weight which becomes so much more necessary as the enemy is approached and the ranges decrease. By the time the reserves are absorbed, the battalion has pretty well done its duty as a battalion in the first line for carrying out the preparation for the final decisive act, and any further advance would probably best be carried out by the successive rushes of half battalions, the men having first ceased firing. By this time probably mass firing would have been adopted.[1] It is a mistake to try and keep up volley firing to such a close range to the enemy as would make it impossible for the men to carry it out from their probable state of excitement, &c. It is much better to watch the instincts of nature, and to guide them into proper channels, than to try and force them against their natural wants, and so make the men very rapidly degenerate into wild license in their firing.

There are one or two points I would like to suggest with regard to reinforcements. The mere fact of the reinforcements being thrown forward is a sign that certain portions of the firing line are exhausted, and I would like to throw out, as a question for discussion, the possibility, on the reinforcement arriving, of allowing the reinforced men to remain behind until such time as they can get pulled together and rested and their pouches refilled with ammunition, and then to be sent forward again as new reinforcements, or with the assaulting body. I am afraid I do not feel personally competent to give a positive opinion on that point, but to me it seems feasible, and if it is

[1] Mass firing may well commence when "fixed sights" are ordered, *i.e.*, at 500 yds.

feasible, I think it will be a very important advantage in preventing the firing line from becoming too crowded and mixed up. Men are often so physically and morally exhausted that they do the most absurd things, firing wildly in the air, and getting utterly out of control, and this only tends to dissipate the control of the firing line and to take it away altogether. If such men could be withdrawn for a while, I do not think it would affect the efficacy of the fire of the firing line, nor the vigour of its advance, in any way, while they might afford valuable assistance at a later period of the battle, for we read in the accounts of the attacks on Plevna by Skobeleff, that one of the means by which he absolutely forced his way into the Turkish entrenchments was by collecting the stragglers and sending them on again as fresh reserves.

Another point I would suggest is that every reinforcement should be imbued with the idea that it has to carry the firing line some distance farther on than it has already reached, and that the unit which receives the last reinforcement that has been sent forward should be the one that should make the greatest effort in this respect, because its men are the freshest and least exhausted, morally and physically. If any one part of the firing line goes on, it will have the tendency to draw the others after it.

These are the chief suggestions which I have to offer with regard to the preliminary period of the attack, that is, for the carrying out the period of preparation up to the period of assault, and I cannot help thinking that some of the suggestions I have offered do give a sound practical solution to this question of carrying out the preparation in such a way as to ensure the greatest efficacy possible for infantry fire under battle conditions. An enormous number of bullets are wasted in action, and nowadays there is likely to be a still greater waste of ammunition, and I think that the acknowledged increase in the destructive power of modern rifles requires a still greater moral control being held over the men. The system of fire units measured by distance will, I fully believe, enable us to do this better than in any other way, because, whatever number of men come into a fire unit, they form part of that fire unit, and will fire by word of command of its commander, and in such a way a far greater control will be held over the men than is the case in some of the systems that I have seen practised by some of the battalions that I have been able to watch. I think this question of fire control is, to a very great extent, a question of organization, and I think we shall have to carry this question of organization into the so-called attack formation, and not trust to mere fire discipline only. My own impression about this matter of fire discipline is that, though it is very necessary, it is not absolutely sufficient. We have also to train the men into habits of reinforcing and of advancing, as much as to habits of firing. We also have to instil into the men the orderly sequence of events by which we gradually prepare the way for the assault by means of advancing lineal formations and firing, and finally bring up for the assault troops formed in column formations of some kind. The men should be prepared for that just as much as they are prepared for

disciplinary purposes by the ordinary drill and fire discipline which they got.

With regard to carrying out the assault, I have supposed that it will be carried out by another body of troops in the rear altogether, and I have assumed here that the battalion is acting in conjunction with other battalions, and that it has no necessity to form any greater reserve than is sufficient for the duty of preparation that the battalion has to carry out. If, however, the battalion is acting alone it would probably begin with a very much smaller front, and here I may refer to what I consider to be an absolute necessity (without exception) for modern war, viz., the provision of ample reserves for all units. This is only an application of the principle of distribution in depth, and if I was asked to choose from among the various principles of tactical procedure for one which should take precedence of all the others, I would choose that which insists on the provision of ample reserves for the use of every leader in his own sphere of action. Every battalion commander should have an ample battalion reserve fitted for the sphere of action that the battalion has to fulfil. And so also every brigade, divisional, and army corps commander should respectively have ample reserves at his beck and call. Every leader is working in the dark. He knows little or nothing of what is in front of him, or of what is going on on each side of him. In this uncertainty mistakes of all kinds are being made. Troops move in wrong directions, orders miscarry, and some commanders act contrary to the orders sent to them; troops ordered to advance or hold a place are driven back; and the most unexpected things occur. Troops drift right and left under fire, or through misapprehension of what is really going on, and gaps occur through which the enemy may penetrate. I know of no better battle to illustrate this than the battle of Beaune-la-Rolande, fought in November, 1870. An account of this battle has just been written by Major Hoenig, who has been allowed every facility of examining the whole of the German archives for all the correspondence and orders that refer to that period of the war, and he has been allowed pretty well to criticise everybody freely all round. He has been given exceptional opportunities of writing the account of that battle, and I do not think there is any battle that illustrates better the value of reserves than that does; in fact, you might say the French attacks on both the right and the left absolutely failed from want of reserves, which caused a fatal hesitation in the French movements when the engaged troops were used up. If they had only had reserves, and had used them opportunely, I fancy that the result of the battle would have been an important victory for the French, but having absolutely no reserves for their right and left attacks they were completely helpless.

Such things as I have enumerated occur in every fight, and will occur in every fight so long as human nature remains what it now is. It would be criminal neglect not to expect nor to provide for them. The best General is he who not only makes the fewest mistakes, but has made provision to rectify those which are made before they become too serious. But how are such mistakes to be rectified, or

their effects minimised? There is only one way that I know of, and that is by the provision of, and use of, ample reserves by every commander in the military hierarchy, each in his own sphere of action. Other reasons for the provision of ample reserves are that men sent into action will, after a certain period, lose their go or offensive energy, and further, that counter-attacks cannot be safely carried out by troops forming the firing line.

These are the reasons why I suggest that should a battalion act alone, it would not extend four companies but would probably extend two only, and hold the others in reserve to meet unexpected eventualities. The primary question is how to prepare the way for convincing your enemy that he has to go. We have in the end to try and assault him at the point of the bayonet, or at any rate to threaten him with such an assault, but in the meantime we have to convince him that it is the best thing for him not to wait for it, and that can only be done by fire. The whole question is, how can we carry out this infantry fire in the most effective way? What is the best method of persuading the enemy to retreat by infantry fire, and of insuring the best effects from this fire? We want to obtain a method which not only gives the best material effects of bullets hitting the enemy, but also the best way of maintaining in your own men that moral courage and offensive spirit which are so necessary to enable them at the last to advance forward to the assault.

Colonel SLADE: I should like, with your permission, to say a few words on one or two points that the lecturer has touched upon, and first I would like to compliment him that, at such very short notice, he has been able to deliver an interesting lecture, and so pave the way for what may be an interesting discussion. There are one or two points in the lecture which I must beg leave to touch upon. The lecturer spoke of two sorts of controlled fire only, viz., "volley firing" and "mass firing." Now, in our Service, there is no such thing known or recognised as "mass firing." We lay down, and we teach the army, that there are three sorts of firing, viz., individual firing, volley firing, and independent firing; the term "mass firing" is not used. Another point is that he regretted that there was no opportunity in England of seeing any description of practical firing. I think there are one or two officers present here who have lately had an opportunity of seeing what we at Hythe hoped was practical firing at extreme long ranges under as far as possible service conditions. As regards the method of attack, it is quite true it is laid down in the infantry drill book that no normal method of attack is permitted, that is to say, no normal method is prescribed; but we know how the infantry invariably practise the attack, because the field firing reports from every battalion are sent in, and not only is the attack carried out by battalions, but frequently by brigades and divisions, and no such firing as "mass firing" is ever used in the British Service. Volley firing is kept up to within about 200 or 150 yds. from the position, and then independent firing is commenced, and, as far as my experience goes from reading the whole of the reports, every battalion in the Service, either acting alone or in brigade or division, carries out "field firing" in that way. As regards the advance, I must say I agree with the lecturer that attempting to advance with small units is one of the most impractical and dangerous ways in rough and broken ground that can be imagined. With all our care in training, if the infantry are to go on advancing in that way on service in rough and broken ground the sections would overlap one another, and the leading sections would mask the fire of those in rear. The proper method, I conceive, would be to advance in one general line, covered by the fire of large units, that is, the half battalion or the battalion, on either flank. If you let the whole battalion go on in one general line it leaves its casualties

behind, and it has the moral impulse of the whole battalion acting together. As regards two companies only in the front line, advocated by the lecturer, I think that is a mistake. In the first place the amount of fire brought to bear would be very small. It would be infinitely better to extend one section of each company of the right half battalion or the left, as the case may be, at first, and then to feed up with the other sections, and keep two sections in support, the reserve to be four companies. I think one section of each company of the leading half battalion should be extended, and the whole of the other half battalion should be in reserve. As regards the battalion commander exercising influence on the fire, I do not think that would be possible. The battalion commander's place is not in the fire line. I do not think it would be possible for the battalion commander suddenly to direct the fire of the whole battalion to any point he liked. I think that would be possible on the parade ground, but not on service under fire.

Captain JAMES: I am in the unfortunate position of having come in very late, and although I have had the advantage of reading the printed lecture, I know that it has not been given this afternoon. The remarks I have to make will be limited strictly to one question, and that is this: assuming we are attacking a position we must look upon our attack formation from this point of view, that we have got a line of rifles going on to the front, and that we want a continuous stream coming from behind to feed that line. The question is how, mechanically speaking, we can best do that. Now, I am very sorry to differ from my friend Colonel Slade, and I do so with the greatest diffidence, but I take it, on the battlefield the thing you have to deal with is mass firing, and for this reason, that on the battlefield, although you aim at one man you often hit another. You very often shoot at A and you hit B, but the effect is practically the same; that is to say, that the fire that produces effect on the battlefield is not fire that I aim at Colonel Hale, or that he aims at me, but the fact that somebody is knocked over, and that is what I call the result of mass firing. This seems to me, therefore, to be the very foundation on which we must build any practical theory of advancing to the attack. If you have a number of men going forward, from among them a certain number will be knocked over, and their places in the firing line must be maintained, that is to say, it is our object and desire to keep the number of rifles in the attacking line complete. What is the best way to do this? Englishmen are all alike in one respect, that is, that we have had no experience of Continental warfare for 80 years. We therefore must go for our information to those who have had such experience. One thing that has struck me, both by reading and by conversation with those who have been under this kind of fire, is this—that the great difficulty is to keep the men in hand, for, on the whole, human beings, whether German, French, or Englishmen, have an objection to being shot, and you have to overcome this tendency by discipline, and the only way to do that is by keeping as many men in hand as possible. Now, the essential feature in the attack is the wave which you have to send to the front, and the only way of keeping the wave going is by having supports or reserves, that is to say, bodies of men who are in hand behind the wave. Now we come to what is detail, but an essential point to be considered. Is it best, taking our own eight company battalions, to have these men in the front line sent in by sections, that is to say, a number of parts of companies in the firing line, or is it better to have certain companies extended in the firing line, and to feed those companies by companies from behind? It seems to me, if my assumption be true, as to the necessity of keeping men in hand, it is far better to have the companies in front and companies behind than to have a number of small items behind the firing line, representing no particular reserve and no particular moral force. I am an advocate, it goes without saying, of having your command extending back in depth, but I do believe as long as we maintain the eight company battalion, it is far better to have the actual supports in the form of separate companies, than to have parts of companies in the firing line and other parts supporting them. I believe this, because you have units which are better in hand, and more capable of being moved hither and thither, and more under the influence of the officers leading them. It further seems to me, in considering this question of command of the firing line, we have two things, essentially different things to think of. One is European warfare, in which, in all probability, we shall never be

engaged; and the other is savage warfare, and we are too apt in discussing theoretical questions to put aside what is the thing we have most to deal with, viz., savage warfare. If my reasoning is true as to the value of forming the reserve behind the firing line in European warfare, ten times more is it true in the case of savage warfare. The whole history of an experience in fighting savages, who are generally numerically superior and inferior in tactics to us, is in favour of having numerous small reserves under the command of men who thoroughly understand how to lead them. I do not hesitate to say, therefore, that in any case, the whole secret of successful leading under fire lies in keeping intact behind the firing line a sufficient force to support it. It always seems to me Englishmen particularly have very little to learn in this respect from the foreigner. The old English line has been an extremely successful attack formation. I remember talking some years ago to Sir Daniel Lysons, and he spoke to me words which I think recent tendencies have proved to be absolutely true. He said: "James, I see no earthly reason why the British line should not still be used." I go absolutely with him in that respect; that is to say, I believe in the line, single rank, properly organized and divided up into units. You cannot command a battalion under fire, I admit, extended in single rank, but you can command sections of it by your company leaders or your fighting unit leaders, and if you adopt the English national tendency to use line, I can see no reason why we should be required to make any very great tactical change in the method of attack that we have always pursued. We in England are always too apt to follow some particular foreign cult. Yesterday we fell down and worshipped the official account of the Prussian war; to-day we are rather apt to despise that and go in for the regimental history. I personally would advise those who think about these matters to study both, but never to forget this fact, that you cannot lay down for any particular nation a line of behaviour which is not suited to the national requirements and national feeling when at war. We Englishmen have distinctly certain proclivities in the way of fighting, and I think we should follow them out, and if we do I can see no reason why we should not be successful in the future as we have been in the past.

Major CAPPER: It rather struck me, as purely a company officer, that the lecturer in making a sort of geographical fire unit strikes at the root of everything that the company officer is taught to value: that is, you take your recruit from the day he joins and train him; he has to look to you as his company commander, you launch him out into the battle, and there you put him under some geographical commander, a man with a certain number of yards, or feet, or inches of the fire line to command. I fancy they would get their heads in the air.

The CHAIRMAN: The section leaders, I imagine, would have the same companies.

Major CAPPER: But I understood the lecturer to state that as the supports came up, and the reinforcements came up into the line, he put that portion of the line which is reinforced under some local fire commander, a commander who had a certain portion of the length of the firing line given to him to fight, and that everybody who tumbled into that was under that officer.

The CHAIRMAN: He meant the company officers who were in command of the sections.

Major LLOYD: There is one point which the lecturer observed upon, and that was that when the firing line is reinforced he should like the reinforced portion to fall to the rear. I think the whole tendency of the teaching of the present day is that our great difficulty as company leaders will be to get our men on, and I think if you allow anybody to fall to the rear the general tendency will be for all the men who have less heart than perhaps the others to fall to the rear also. Thus the company leader's difficulties would not only be increased but would be more than doubled; as it is you would have sufficient difficulty in looking after the fire discipline and getting the men on, you would also have to look after those men who fall to the rear in the ordinary course, and to try to get them on. No doubt Skobeleff, in the attack at Plevna, succeeded in bringing on the men left behind, but in all probability he brought on those men who were left behind through necessity and not those who had been left behind on purpose. Had he been obliged to bring on both together he would, I think, have found that the firing line had become extremely thin. There is one other small point I would like to allude

to, and that is about this battalion extending. The Drill Book is my bible, and the Drill Book says that we are to extend in a shallow formation when we prepare for attack. When the battalion is brought up and it is found necessary to extend, it is presumable that it is not under cover, and therefore the four leading companies are sent out, and I imagine that the Drill Book does not intend them to be in section columns. If they are in section columns they are in a deep formation, and a deep formation is much more liable to suffer from a heavy fire than a shallow formation. If it is necessary to extend at all, I think that it should be to line or at an interval of one or more paces. If, however, the force in question could be brought up in a deep formation it would be better for the battalion, half battalion, two companies, or whatever it may be, to advance in the deep formation, and then, when the time came for extending, to extend at once into line, or into an extended line or single rank, as the case may be, and not into the deep formation of section columns.

Lieutenant-Colonel E. GUNTER: I do not quite see the point of the lecture, but there is a question in it on which I should like to support most strongly the speaker who has just sat down. It is not a question of formation, but it is a question of main principle, that the men in the firing line should certainly not lie down, and should not be allowed to retire at all with a view of getting replenished ammunition. The lecturer has quoted the case of Skobeleff on his attack, I think, on the Green Hill. I think that clearly showed the skill of Skobeleff in collecting men who *had* so retired, and is not an argument for their being *allowed* to retire. I think Major Lloyd has well said it is the greatest difficulty to get forward men who will lag behind, but do not let us reproduce it as a matter of drill for attack that the men are to do so. Let them, by all means, go on to their death (and most of them will die in the first line), and let it be understood that that is their duty, and that reinforcements must come up from the rear in the second line afterwards.

Captain JOHNSTONE, R.E.: I should like to ask one or two questions. In the first place as to the command of the firing line. Colonel Slade has told us that it is impossible for the battalion commander to exercise a control over the whole firing line. If I rightly understood the lecturer, he suggested that it should be done by a half battalion, and I should like to ask him who is the officer who he intends to take charge of the half battalion firing line? Is it to be the major of the half battalion?

Captain MAYNE: I meant the second in command should take command of the whole battalion firing line, both with regard to the firing and reinforcing.

Captain JOHNSTONE: Then there is another question. He has spoken of the commanders of the fire units. In the first place we were extending one section of each company, then a second section; the commanders of these sections would be, at all events in the first instance, commanders of the fire units. Was it intended that these same officers (or in most cases non-commissioned officers) were to continue to be the fire commander of that unit, or was it intended that as the reinforcements came up the senior officer, if he happened to be the senior of the first fire unit commander, was to take over that fire unit; in other words, was the fire unit to go the whole way under one commander, or was it to be changed from time to time? That seems to have a bearing upon whether you should extend by companies and reinforce by companies, because if we have one section extended in the first instance, we are reinforcing with men of the same company, and going on with officers of the same company. If we have a company extended reinforced with another company, we at once have the officers of the two companies more or less mixed up. I know in ordinary peace manœuvres sometimes a little confusion used to occur in that way.

Colonel TROTTER: As I understand the lecturer that he would only have two companies in the firing line, I should like to ask whether if that is the case—

Captain MAYNE: I was referring to the formation of each half battalion.[1]

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[1] The diagrams were drawn on the blackboard, and to save time only the right half of the battalion formation was drawn.

Colonel TROTTER: I want to ask whether he thinks it is advantageous that the second line should be formed by the same battalion. It always appears to me, if the first line carries a position and then has to give it up to the second line, that it would be very much better, to prevent any sort of ill-feeling or difference between battalions, the second line should be formed by the same battalion.

Captain MAYNE: I have asked General Clive's permission to make a few short replies to the queries raised before he makes his concluding remarks. As you all know, I am not an infantry officer, and I have purposely avoided laying down any strong opinion about some questions, owning that I do not feel myself fully competent to deal with them from practical experience. I therefore asked General Clive to follow me in my remarks, and to correct anything wrong that I may now state, as I am rather having the last say, and I do not want that if I do say anything wrong. I must offer my apologies to Colonel Slade with regard to the use of the term "mass firing." I know that it is not an authorized expression, but I have used it in a different sense to what he thought I meant by it; I also used it in a different sense to what Captain James used it. I have used it in this sense: Volley firing is an organized fire by organized units; mass firing is general and unorganized, though controlled, firing. It is the whole line firing as one huge unit, instead of firing by organized units in the line firing. I know it is controlled individual firing, and I meant it in that sense. With regard to the field firing, to which Colonel Slade has referred, I contemplated in my remarks it being carried out on a very much bigger scale, a regular camp of instruction on some ground where you are not limited to range. There surely must be some bits of waste land in England, with a sea or mountain backing, on which real imitation battles may take place, and where artillery may also play its part with real live shot and shell, as is done so often in India, so as to make it a thoroughly instructive practical imitation of a battle, so far as it may be carried out in peace-time. With regard to changing the direction of the fire of a battalion by the officer commanding the battalion, I know that it would not be done on many occasions, but suppose for an instant a battalion was advancing, and some distance off to a flank there was another battalion also advancing, and the officer commanding one of these battalions saw coming out of some wood or ravine in front an attacking party of the enemy, which proceeds to advance against the flank of his neighbouring battalion, but which was unseen by the latter at present, it would be a great advantage to have some system by which he might send word to his firing line to direct the whole of the fire of his battalion on to this body which was seen going to attack the neighbouring unit, but which the neighbouring unit was unable to see. Then as to the system I have suggested of letting the different fire units fire in succession, like the guns of a battery; I believe the result would be that you would get a higher percentage of hits than at present, while obtaining an ample quantity of fire, and yet you would leave the whole battalion in the hands of the commanding officer, so that he could, should occasion require, be able to direct the fire of his battalion on to any point. With regard to Captain James's remarks about the stream to the front of men being required to keep up the firing line to its full efficacy, of course that is a general principle with which we all agree. But what I was endeavouring to arrive at is how to organize that line at the outset, and, as the stream arrives into it, how to keep it organized for the purpose of maintaining an organized fire. That is the difficulty, and I have tried to suggest the best manner in which the stream of men who are coming up are to be organized in the firing line, because we do not want the men to fire wildly; we not only want to get the men there, but also, when they are there, to have their fire under control, to be used to the most effective purpose. Whether one company extended in the firing line with another company in support is the best way or not is, I fancy, a matter of pure practical experience, and that is one reason why it would be such an advantage for infantry to have a camp of practical instruction, in order that these various proposals may be tested against targets, so arranged as to represent an enemy, while using real bullets, shot, and shell, so that we may actually see which are the best ways of carrying out the fire preparation and an attack. We may argue for days and days as to what is best theoretically, but what we want is a practical test, and I do not see any other way of testing which is the best without some such practical advantages as the artillery

have. Major Capper spoke of my suggestion of fixed fronts for fire units. He used an admirable expression for describing my views, namely, "geographical units" and "geographical commanders." This just hits off the idea which I had. The only other question I would like to ask is this: the units have to be mixed somehow; we may try and prevent the mixing of large units or small units at the beginning of the fight, we may try and prevent companies mixing up to a certain period, but after that we find that they do become mixed. We often read in accounts of battles of battalions being piled on battalions, and even taking the case of Tel El Kebir, even at the short distance over which the assault did take place—I think I am right in saying that it was only 300 or 400 yds. from the entrenchments—actually when the men got inside it was not a question of the companies being mixed, but it was a question of battalions being mixed. I remember reading an account by Colonel Maurice, R.A., in which he said that the mixture of men in the redoubt was a mixture not only of companies but of battalions over that short distance. Therefore, in the stress of battle we have to deal with the mixing of large units, and my proposal simply was a suggestion by which to try and control, in some way or other, these bodies of men when the units are mixed, and if maintenance of command by geographical units will secure it, surely that is an advantage; but here again I say these proposals are of very little value until put to the test. With regard to what was said by Major Lloyd and Colonel Gunter as to the original firing line falling to the rear, I did not mean for them actually to retire, but to remain lying or standing where they were. I would like to ask infantry officers one question for their consideration: the mere fact of reinforcements being sent into the firing line is an indication that the firing line is more or less exhausted, both physically and morally. What good are those men? Is it any good their going on in this exhausted condition when they are probably so morally disorganized and their fire has become so wild that in the one or two small actions in which I have had the honour of being under fire I have actually seen officers take away their men's rifles in order to steady them down again? When that kind of thing takes place, what good is it allowing these men to go on? Would not it be better to let them remain behind and get steady? A little repose will steady them, and will allow of their ammunition pouches being refilled. I do not say, however, that I am really capable of giving a decisive opinion about it. Another of Major Lloyd's objections is to the extension of these companies. I think he has misunderstood me. When the battalion comes near enough to the enemy's artillery in its quarter column formation to become a dangerous target, I do not think there is any necessity to go on until it does become a target which suffers. As soon as danger comes it is better to break it up into smaller targets which are not so dangerous, and then I say, as soon as these targets are in danger of suffering much, then let them extend. I think you will agree with me that extension is only a dodge to avoid losses. At the same time it brings in the difficulty of control over the men, and the great advantage of keeping men in close order formation, or even in column formation where possible, is the better control you have over them; you have them better in hand, and you keep a stronger moral tie and force over them until such time comes as you have to let them go. When the solid battalion formation becomes too dangerous, break up the battalion into smaller units without waiting for it to be proved. After this you can advance the smaller bodies, and when they become dangerous or likely to suffer, then extend them in such a way that you will keep your men as much in hand as possible, until the full extension has to take place. With regard to Captain Johnstone's objection, saying that the non-commissioned officer might be commanding in a fire unit, I do not see any reason why the non-commissioned officer should not continue to command. Naturally the officers who arrive would take care that the words of command were correct. The men have got accustomed to his voice as they advance, but he is acting under the control of the officers in the firing line, who, I think, are much better employed in watching and looking out than in giving words of command of that nature. And I think most non-commissioned officers have rather better voices for command than officers, so perhaps it would be better for them to do this, while the officers devote their attention to the higher duties of observing the enemy and seeing that the men obey the orders that have been given. The officers would pass all words

of command to the non-commissioned officers, who would give the executive command as to what is to be done. I can see no objection to change of command, because, as soon as units get mixed up, and as officers are shot down, changes of command will take place, and there is always a larger percentage of British officers shot down than in any other nation. As officers get shot down, changes of command must take place. Then as to the question asked by Colonel Trotter; there, again, I can only offer a tentative opinion as to whether the second line is best formed by the battalion itself or by a second battalion. The only answer I would suggest is that it would be better to be formed by a separate battalion, for this reason, that it is just possible that the second line may not be required to assist in the fire preparation. The first line, through the fortuitous concourse of circumstances, may be able to carry out the duty assigned to it without calling on the second line in any way to take part, and, that being so, there is the second line battalion remaining for any subsequent duty that may be required, such as to begin the pursuit until some organized body can take it up, or to assist in covering the retreat; whereas, with one half of a battalion in the second line, you would not like to detach it from the half battalion already engaged in front. By having a free second battalion in the second line you can march it away in any direction without breaking up the battalion unit.

The CHAIRMAN: Gentlemen,—I have not many remarks to make, but I feel certain that, one and all, we have come here with the intention of trying to solve the problem how a battalion is to be enabled to advance over a fire-swept zone with the least loss, and in the best order for continuing the advance. Captain Mayne is of opinion that, although the accidents of the surface and the cover of broken ground may prescribe the order, whether of columns, half columns, or sections, in which the attack is to be made, the problem yet awaits solution, What is the best order of attack, and how can troops be advanced with the smallest amount of loss? We appear to be all agreed that the attack order of the New Field Exercise is the best, *i.e.*, that the attack shall be made in three successive lines; the first or firing line, consisting of firing line, supports, and reserves, followed by two others. The object of the movement being progress, it is believed that the entry of the supports into the firing line will carry that line farther in advance, and the entry of the reserves will continue that movement, so that the whole attack may arrive at a point from which an assault may be made, as the final act of the manœuvre. In my opinion, the danger lies in not appreciating at its true value the effort which will be necessary. We talk and read in books of getting up to within 800 or 500 yds., or to some point from which the assault may be delivered, without considering that the wave or waves of troops we have sent up may be quite insufficient for the purpose, if the enemy's fire be strong enough or his position sufficiently good. The point we have to consider is, how, in the face of an unknown force of fire, and a position possibly not exactly reconnoitred, we can bring our men up in the best heart and condition to continue the advance. Sections will be mixed, companies mixed, battalions, and, in great battles, brigades mixed, and the best must be made of it to restore order and cohesion at the first halt. Colonel Hale, and plenty of officers in this hall, can tell you how many men per yard at St. Privat it took, not

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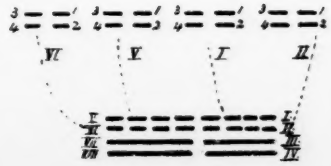
Note.—Since the above lecture was delivered, the attack, conducted on the principles laid down in it, has been put into practice by one battalion, and has given every satisfaction as regards giving control over the men and over their fire, individually and collectively. The advance by rushes was conducted by the successive advance of fire units, the adjacent fire unit only ceasing fire to prevent the advancing men being fired into. In this way every fire unit (except one) can keep up its fire in its turn, and thus prevent any serious cessation of the fire of the battalion. The reinforcements were directed right and left at the fancy of the battalion commander, so that the company units became mixed, and in spite of this the control over the men and over their fire, individually and collectively, was exceedingly well maintained, orders were easily circulated, and the fire of the battalion, as a whole, was without difficulty directed on different named objectives. —C.B.M.

to carry the position, but to fail to carry it; and, if the defence is strong enough, this is what we must prepare for. This is so important that I feel sure we should all have welcomed Captain Mayne's suggestions for solving this problem: (1) how to get the men up with the least loss, and (2) the best order of attack. Captain Mayne is an officer of great ability; he has studied the subject and written upon it, his "Fire Tactics" being a standard work, and I am sure his suggestions would have been valuable. However, as we have been deprived of them, I will ask you to let me be your spokesman in giving a vote of thanks to him for the lecture he has delivered, and another in anticipation for the lecture which we still hope to hear.

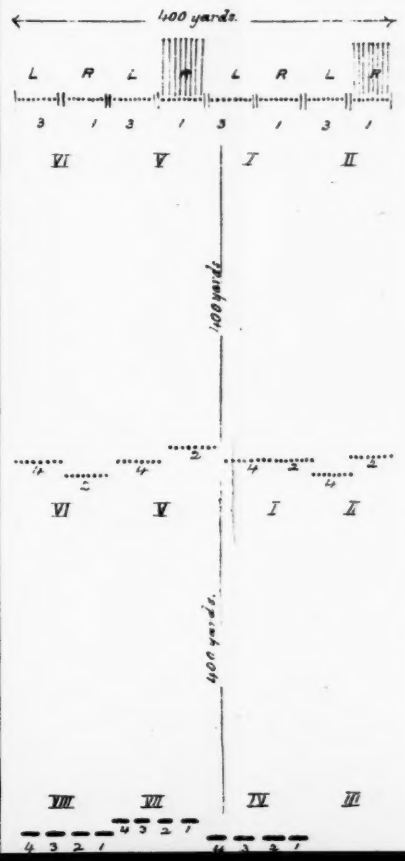
1st Deployment.

Fig. 1.



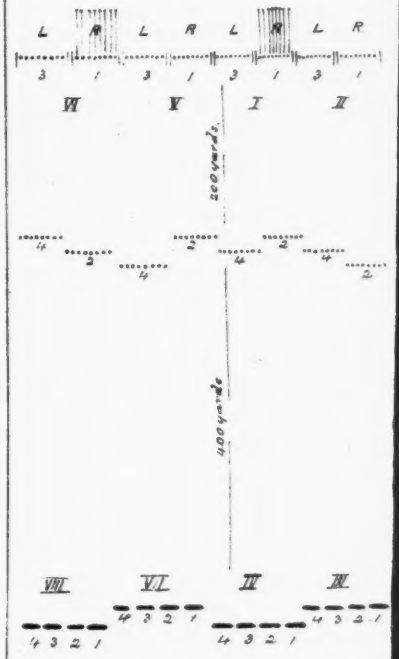
1st Extension. 1000 yards. Firing line extended to 2 paces intervals. Volley firing in succession by R. and L. fire units from right of 2 battalions. Battalion advances as a whole.

Fig. 2.



900 yards. Firing line, firing and advancing as before.

Fig. 3.



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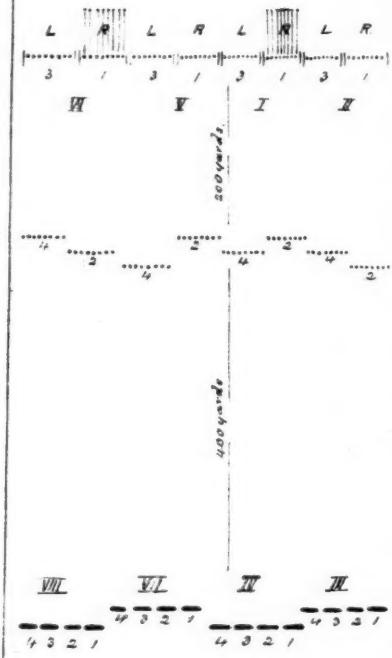
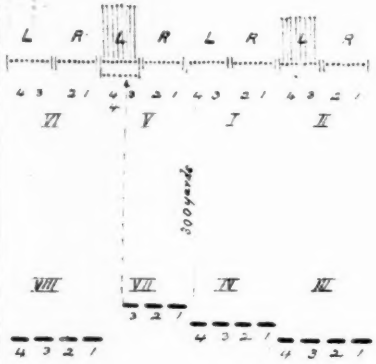
900 yards. Firing line, firing and advancing as before.

Fig. 3.



700 yards. Firing line firing, and advancing as before. Left fire unit of V Company reinforced. Firing line has a strength of one man per pace.

Fig. 4.



500 yards. Indiv
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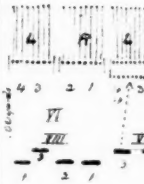
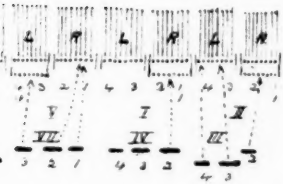


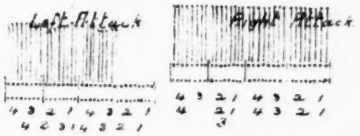
Individual firing with limited rounds, volled by whistles begun, and with ights. Advancing as before except company front as a whole is the ing unit.

Fig. 5.



300 yards. Individual firing with fixed sights and fixed bayonets. Advance by successive rushes of alternate ½ battalions, the men nearest the advancing ½ battalion cease firing.

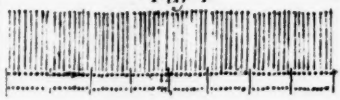
Fig. 6.



200 yards. Individual firing with fixed sights and fixed bayonets.

Time waiting for assaulting troops (coming up in rear) to carry it forward.

Fig 7



The troops in rear will advance to carry out the assault, when the firing line can no longer advance.

Friday, May 18, 1894.

BRIGADIER-GENERAL THE RIGHT HON. LORD BELHAVEN AND STENTON in the Chair.

SIGNALLING: PRESENT DEFECTS AND SUGGESTED IMPROVEMENTS.

By Lieut.-Colonel A. STEWART HARRISON, V.D.

To a professional audience, such as I assume the present to be, it is unnecessary to dilate upon the importance of the question of marine and military signalling. It goes without saying that no co-operation is possible unless communication can be established at a greater distance than the voice, expression of face, or natural motions of the arms, will go, and that signalling of some kind is a necessity.

I do not propose to use the few precious moments entrusted to me in dealing with the history of signalling, but I propose to devote the whole time at my disposal to a consideration of three points.

First—What constitutes an ideal system of signalling, and what are its requirements?

Second—What is the actual condition of signalling at this moment? And,—

Third—What I propose in substitution of the present systems, as the nearest approach to the ideal system.

I may venture to point out that I do not propose to distinguish markedly the necessities of naval, mercantile marine, and military signalling; my belief being that the system which is best for one is best for all. By system I mean the "principle" as opposed to the mechanical details of working it.

What, then, are the requirements of an ideal system of visual signalling? They are—

First—That it shall be adapted to all conditions of light, night as well as day; dull weather as well as bright; and be available under all or any conditions in which anything else is visible.

Second—That it shall only require apparatus of the simplest character for entire efficiency; while capable, with increased complexity of apparatus, of the highest speed in signalling which can be sent and read.

Third—(*a*) That it shall have a different sign for each letter of the alphabet, and (*b*) that each letter shall be complete in itself.

Fourth—That it shall remain unaltered, and under constant observation till acknowledged by the receiver, by repetition or other sign.

Fifth—That it shall be easily learnt and remembered by association with some other idea.

Sixth—That it should be founded on some common and well-understood principle or rule, by the knowledge of which the whole code can be recalled.

Seventh—That it shall be capable of use by any one possessing a copy of the code, without any previous knowledge of it, or the mode of working it.

Eighth—That it shall be capable of transmitting signals invisible to anyone but the intended receiver.

Ninth—That it shall involve the least possible movement of the sender, so as to attract as little attention as possible from those for whom the signals are not intended.

Tenth—That no distance at which anything else is visible shall prevent its use.

Eleventh—That its use can be continued by both sender and receiver without excessive mental or bodily fatigue.

Twelfth—That it shall be capable of being used by sounds, where conditions of light fail.

It seems to me that a perfect system of signalling must fulfil these conditions.

Taking the first condition—"That it shall be adapted to all conditions of light, night as well as day, dull weather as well as bright, and be available under all conditions under which anything else is visible"—I think this scarcely requires enlargement. That the signalling should be the same for day as well as night is certainly essential unless *two* systems are to be learnt.

"That it shall only require apparatus of the simplest character for entire efficiency." There are hundreds of circumstances in which communication is desirable or necessary—more particularly in naval signalling—where no special apparatus whatever can be carried or its possession ensured. If, therefore, the communication depends on the possession of special apparatus the system will fail. But the definition goes on to say, "while capable, with increased complexity of apparatus, of the highest speed in signalling which can be sent and read."

The highest possible speed of a visual signal is limited to an exposure of not less than one-eighth of a second, that being the time required for an existing impression in the eye to fade away; but I think it more probable that a safer rule for speed would be from half to three-quarters of a second, and this would give from 90 to 120 impressions or signs per minute, a speed amply sufficient for all practical purposes.

Then as to the third condition—"That it shall have a different sign for each letter of the alphabet, and that each letter shall be complete in itself"—I am not now discussing what information shall

be conveyed by each letter, but simply that there shall be one sign only for each letter. I regard this condition as of considerable importance.

With regard to the completion of each letter in itself, if we imagine the letters of a newspaper or book cut up into two, three, or four different pieces, and stretched horizontally along a line, I think we should, in adopting any such method of printing, have to considerably lower the School Board Standard for reading, or raise the age for the attainment of the standard.

The fourth condition—"That it shall remain unaltered and under constant observation till acknowledged by the receiver"—is most important, taking into account the conditions under which signalling is usually carried on. Wind, accompanied by spray or rain, affects the receiver's eye. Noise of firing, heavy and rolling movements, &c., disturb his mind and distract his attention. Spray passing between the receiver and the sender; masts and spars, or other objects; all these point to the necessity for this important fourth condition.

Then, by the fifth and sixth conditions—"It shall be easily learnt and remembered by association with some other idea, and be founded on some common and well-understood principle or rule, by the knowledge of which the whole code can be recalled"—is a reminder that man's memory for isolated facts is, in most cases, weak; hence the multiplicity of systems brought out for assisting the memory. There is one in which geography is taught by the relative positions of eyes, nose, mouth, &c. Shorthand is taught by reference to the face and its curves; and we have seen an ambitious attempt to get the French Verbs into the *inside* of the skull by association of ideas with objects *outside* it—hair, teeth, eyebrows, and the like.

That these various systems for improving or assisting the memory exist is an admission of the principle that ideas are more easily retained by association than by other methods. And in regard to a rule or principle, as opposed to an arbitrary arrangement for signals, I think it must be admitted that the rule has the advantage.

In arithmetic, for instance, those not accustomed to making arithmetical calculations every day have to recall carefully and repeat the words of the rule which covers the particular case. Then the knowledge comes back, and the sum is solved.

The seventh condition requires that "it shall be capable of use by anyone possessing a copy of the code, without any previous knowledge of it." Here, again, it will be remembered that there are hundreds of circumstances in which persons may be placed who have no previous knowledge of the code, but *may* possess a *book* or card in which the code is laid down. Now, if it be possible, it is certainly desirable that those persons shall be able to make use of the book without that previous knowledge.

The eighth condition stipulates that "it shall be capable of transmitting signals invisible to anyone but the intended receiver." I regard this as of some importance in military warfare. I believe it would be perfectly possible (by previous arrangement) for communication to be made between persons at any distance apart

(with the proper apparatus, of course), which would be absolutely invisible to anyone but the observer for whom they are intended.

The ninth condition—"That it shall involve the least possible movement of the sender, so as to attract as little attention as possible from those for whom the signals are not intended"—certainly applies, as the preceding condition, to the circumstances of warfare. It is quite clear that it would be the first duty of an enemy to put a stop to all signals by opposing forces as much as possible. I am confirmed in this view by no less an authority than Capt. Orford Churchill, R.N., who speaks distinctly of the danger of signal halliards for flags being shot away, and of the exposure, and consequent risk, to which the signal men are now subject.

In the tenth clause—"That no distance at which anything is visible shall prevent its use"—we have clearly another very desirable condition, and one which, provided there were apparatus of sufficient size, even of the simplest kind, there should be no difficulty in fulfilling.

By the eleventh condition—"That its use can be continued, by both sender and receiver, without excessive mental or bodily fatigue"—we have a reminder that, the greater the simplicity of a system the more restful will it be, and the longer its use can be continued; and, other things being equal, the system which a man could continuously use for two hours would be a better system than that which incapacitates him, by mental or bodily fatigue, in one hour.

The twelfth and last condition I have enumerated—"That it shall be capable of being used by sounds, where conditions of light fail"—is a provision for the contingency of fog or thick weather rendering the eye useless, and the signalling system should, in such cases, provide for sound being substituted. And, further, the system is not perfect if the same knowledge which enables the eye to take in the signal does not, as well, serve for the ear.

I will now proceed to consider the various methods of signalling in use in this country; and so far as I, as an outsider, have been able to ascertain, they consist of flags which, by their shape and colour, mark the letters of the alphabet or convey some other intelligence.

I will venture to put forward my opinion and say that the day of flags is clearly past. The rapidity of movement, say, for convenience, 20 knots an hour, means that a vessel covers her own length of, say, 300 ft. in about 9 secs. How is it possible to give orders, involving two or three hoists of flags, from a vessel moving in one direction, to a vessel moving in the opposite direction at the speed named?

It means this: that the ships are moving at more than the average rate of express trains—nearly 45 miles an hour; that they are as rapidly changing their positions; and that in a long message the flags are in a totally different position at the end of a message to that they were in at the beginning. And this is most important, for a flag is at its best in only two positions—when the wind spreads it out from the halliards direct to the observer's right, or when it is to the left. It is, of course, quite useless in a dead calm.

Every departure from this ideal position decreases its usefulness,

until the decrease has culminated in the flag being blown in the direction directly to or from the observer.

On these grounds, therefore, I think it is hardly worth while considering the use of flags as capable of being retained for serious purposes of signalling; and further, because of their defects, they have, in the navy, been supplemented or superseded by other forms of signals.

In the mercantile marine, when distance has taken all the colour out of the flags, a distance system is used, in which a pointed flag, a square flag, and a ball, play their parts, irrespective of colours. But, in that case, it takes two flags and a ball to make one letter.

Analogous to this system may be mentioned the boat systems, in which a piece of flat board, a square handkerchief, and a round hat play the parts of ball and flags in the distance system of signalling.

In the navy the flag for day use has been supplemented by a semaphore, the position of whose arms indicates the various letters. The arms are capable of assuming seven different positions, and there are apparently two or three arms, pivoted centrally, so that a very large number of combinations can be made. And to see, for the first time, a semaphore in active work gives one a very vivid idea of the intelligence and training required to read these frantic and apparently purposeless wavings.

There is still another form of semaphore (that of the mercantile marine) in which there are three arms (pivoted at one end, at different heights on a pole) whose position indicates the square, pointed flags, and ball of the distant signalling.

All these serve for *day* signalling, to which, however, must be added one other form, the flag waving or Morse system. In this system a flag makes a passage of greater or less length in a quadrant in front of the signaller. The short motion is a "dot" and the long motion a "dash" of the Morse telegraph code. So far as I know, these are all the daylight systems which are in use, and consist of, as you have seen—

1. Flags.
2. Semaphores.
3. Distant signals.
4. Boat signals.
5. Mercantile semaphore; and
6. Dot and dash.

To these we may add another system, though little is known of it, and it is not in general use—the private system of the late Admiral Tryon. We thus have seven distinct systems of signalling, each with its own rules, its own laws, and its own code, *for daylight only*. For night we have one system—the flashing of the Morse code—by which the long and short exposures of a light are understood for the signals.

The same knowledge which interprets the flag waving also interprets the "dot and dash" at night, but I am of opinion that however much

the world owes Morse for his ingenious code in connection with telegraphy and its instruments, it owes him nothing for the use of his alphabet for visual signalling. After years and years of trial (from, I think, 1863) the complaint comes that you cannot get men qualified to read these signals except after long and painful training. And the reason is fairly clear. The signals were originally meant for impression upon a ribbon passing through the telegraph instrument whose only possibility of movement was that of a lever detained a longer or shorter time in connection with a magnet to record those lengths of time. After a very short interval the ribbon became merely a corroborative record, and the whole work of receiving has been done, and is now being done, by the ear alone. Nearly every Morse operator in the world now listens only to the "tick——tick, tick" of the instrument, while at the same times he writes down what it says, only, and very rarely, referring to the ribbon when some doubt arises as to his correctness of interpretation, and the present visual signallers are taught, at the beginning, by the ear alone.

And this is what you might have expected. The ear does not take in a whole symphony at once; it does not listen to a whole melody; it takes in the notes separately, second after second, and the ear memory merely builds up the melody afterwards.

This power of the ear to distinguish sounds is worth a moment's consideration. I find by experiment that by playing 31 bars of Blumenthal's "La Source" in one minute, there are emitted from the piano 700 distinct sounds, each of which is part of the structure of the air itself, and any one of which would be missed by a trained musician if omitted; the eye can pretend to nothing like this rapidity.

What judgment could the eyes form of the finest picture in the world, if the picture were presented to it through a slit in a plate passing over the picture moving at this rate? Hence, when you ask the eye to memorise the dots and dashes which go to make up the letters intended you appeal to the wrong organ, and the most melancholy of failures is the result, and you are even obliged to educate the eye for flashing signals by first educating the ear, and there is this *difficulty, that the motion of the sounder lever is about the eighth of* an inch, while the motion of the flag is measured by feet; one is a *movement of the finger, the other of both arms, and time is taken* from the finger's motion.

But the telegraph operator has an additional advantage of great value—the imprint on the ribbon is *visible*, he can see what has passed; the signaller has to trust his memory alone, the flash or *wave of the flag leaves no mark.*

In considering further applicability of the Morse code for the *purposes of visual signalling, I should like to point out that an* analysis shows (as indicated in the diagram I on the wall) that there are in receiving the letter X, of 4 *elements with the lamp, 4 light* presentations, timed; 4 dark presentations, timed; 4 contractions of the iris, variable as to time; 4 expansions of the iris, also variable; *and that there are 14 time judgments, and 8 volitions, muscular*

efforts and recognitions of result, assuming the eye to take no part in sending.

Taking the whole Morse alphabet (diagram II) there are 44 dots and 38 dashes, making together 82 light signs. This gives an average per letter of $3\frac{1}{5}$, and taking the 64 letters per minute divided into 16 words of 4 letters, which is the standard test, we get 202 light presentations, 202 dark presentations, and 202 dark intervals.

But these intervals and the dots and dashes are timed, the dot intervals being equal to 1, and the dark intervals to 3, so that, dividing the alphabet into periods, we have 44 dot signs; 38 dashes multiplied by 3 equal 114; 56 dot intervals and 26 dash intervals multiplied by 3 equal to 78, so that the sum stands thus :—

44 dot signs	equal	1	=	44
38 dash „	„	3	=	114
56 dot intervals	„	1	=	56
26 dash „	„	3	=	78
Total				292 time intervals.

This divided by 26 gives $11\frac{1}{5}$ as the average of the 26 letters.

Taking then the 64 letters and multiplying by $11\frac{1}{5}$, we get 716 periods for the standard test. To this must be added 16 additional dash intervals of 3 between the words, making 48, thus the grand total of periods in the test minute is 764; dividing this by 60 we get each second divided into periods of $12\frac{3}{4}$.

Reviewing these figures (see diagram III) we get in the receiving signallers minute

16 words of 4 letters, in all 64 letters;
764 time judgments, or $12\frac{3}{4}$ per second;
138 states of suspense as to meaning of signs as letters;
48 states of suspense as to meaning of letters as words;
202 light presentations, 1 to 3 in period;
202 dark presentations, 1 to 6 in period;
202 variable contractions of iris for light, and
202 variable expansions of iris for darkness.

In the case of the small flag, as nearly as I can find it travels at the rate of $8\frac{3}{4}$ miles per hour.

In addition to this the signaller has to exist as a human creature, to feel the sun, the wind, and the rain, to feel tired or fresh, angry or pleased, puzzled or clear, happy or miserable, and to carry on his work, involving the life or death of hundreds, amongst *the noises* and sights of battle on sea or land.

Looking at all these duties reflectively from the standpoint of the physiologist and the psychologist, one is irresistibly driven to *the conclusion that a man who can do all this, minute* after minute, hour after hour, must be a very rare and remarkably constituted being, and the question will arise as to whether there is any confirmation of this view in the experience of the *30 years during*

which the Morse code has been in use for the purpose of visual signalling in the two Services, and this evidence is not wanting.

Not long ago I saw a report of an examination in signalling in the army, and the best (a troop of Royal Engineers) came out with 98 per cent. of signals read correctly; and the lowest (I have carefully forgotten who they were) came out with 50 per cent. read correctly.

The objection to this "dot and dash" system, as applied to anything but the telegraph instrument to be read by the ear are very great; one of the principal being that no man of average ability can possibly learn it, with any useful results, after the age of 30; and I do not think, taking a hundred men *at random* from a regiment or from a ship you would find, at the end of three months' average training, ten of them capable of sending and receiving these signals with a reasonable degree of accuracy and rapidity.

During the discussion after a lecture delivered in this room on Friday, February 10, by Colonel Keyser, Inspector of Signalling, the lecturer admitted that out of 20 men *selected* from a regiment as fit and proper material for training into signallers only three, as an average, attained that position; that is to say, after 50 working days of training the waste was 85 per cent. of the material.

Is it to be wondered at that the Board of Trade should decline to compel, even if they could, the mercantile marine to train its officers and men in a mode of signalling in which, after three months' labour, which, in this case, would be carried on by the officers and men at their own expense for living and fees, 85 out of every 100 would fail to get a certificate?

It is impossible to lower the standard, because a man must signal properly or else not at all; and nothing can show how utterly unfitted the dot and dash system is, in itself for visual signalling, than the statement of the fact that 85 out of every 100 must fail.

No commercial firm would for a moment entertain a proposition to manufacture an article with this enormous proportion of waste, and it is only the boundless resources of a Government and the indifference of the public that allows such a system to continue to exist.

I should like to say something, if there were time, about the evil effect of these failures on the minds of the 17 rejected, but time does not permit. The matter, however, is certainly worthy of the greatest consideration by those who know what the life of a soldier or sailor really is.

With regard to this question of night signalling, and the difficulty of learning to use and read the flashing light, I may mention that in 1878, in this room, in a discussion on Silber's lamps, I drew attention to this point, and stated that, to the best of my belief there was no system of night signalling in the mercantile marine of the world. Admiral Colomb, who followed me, took up and enlarged upon this point in a very forcible manner; but to this day I believe nothing has been done.

That thousands of lives and millions of property have been sacrificed in collisions, some of which—nay, I say the greater part of which—could have been prevented by an intelligent use of night

signals, is undoubted. And it has been charged against the Board of Trade that they have remained callous and absolutely indifferent to this question. But the more I have looked into the matter the more I have been disposed to exonerate that Board from blame. When we here have agreed to a reasonable system the Board and shipowners can be fairly called upon to do their duty—at present it is only decent for us to be silent; and meanwhile I think I may fairly ask of what use will be the fast steaming cruiser scouts, that have been subsidised at a cost of some 34,000*l.* per annum, if the officers and crews of those vessels are unable to signal the information they gather, for at night they cannot signal, as they do not understand the flashing signals, and in the daylight their 20 miles an hour will drag the flags behind them so that they cannot be seen.

I admit with the utmost freedom the extreme simplicity of the apparatus employed in the flag and lamp system; but I venture to ask what is the use of a system with simple apparatus for its main point when the man in front of it cannot use it? It is a matter of notoriety that during the late manœuvres—commented upon by every paper, and commented upon in the professional magazines—the signalling hopelessly broke down. "More and better signalmen" was the cry of the whole fleet. But when we remember the fact that a man has to learn 12 if not 13 or more systems or modes of signalling before he is competent to deal with the apparatus on board one of H.M. ships, and to read signals, from the mercantile marine and those from the army, as well as those from foreign warships, I confess I am not astonished. And I believe every naval officer, and I may say every army officer too, who has gone through the ordeal will admit that one of their most painful experiences was their incompetence to make, take in, and understand the signals that were made by them or to them under this Morse code, while they felt confident of their ability in all other duties entrusted to them.[1]

I here give a list of the signals I refer to.

Flags.	1.—Navy.
Colour.	2.—Merchant.
Form.	3.—Distant merchant.
	4.—Boat merchant.
Position.	5.—Semaphore naval.
	6.—Semaphore merchant.

[1] The lecturer exhibited a pair of black signal screens with the nine silvered dots which were covered and uncovered with vertical shutters by pushing and pulling two handles, with a motion of 10 in. each, and a third, with about 3 in. for the pendant. These were direct action, but he expressed his preference for quadrant levers or screw action. For the Admiral's vessel, he also exhibited a crow's nest for signallers balanced on a central pivot, so as to keep level with the horizon. The form was a hexagonal cabin, glazed and roofed for shelter, on top of which was the hexagonal group of signalling screens, to signal as nearly as possible all round. The lights or discs would be worked from the cabin below.

The diagrams below were shown on the walls.

He showed also some silvered metal discs attached to the bayonet for signalling

Time, motion.
7.—Dot and dash, flag dipping by day.
8.—Dot and dash, flag waving.
9.—Dot and dash, heliograph.
10.—Dot and dash, night flashing.
Tune.
11.—Dot and dash, long and short sounds.
12.—Admiral Tryon's system.
13.—Foreign war-ship signals.

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by a group of nine men on a ship's yard in a horizontal position, and some folding discs for a similar purpose in the field.

MORSE CODE.

Lamp Signal, letter X.

Sending.				Receiving.				
				Presentations.				
Time judgments.	Volitions.	Actions.	Recognitions.	Light.	Dark.	Contractions.	Expansions.	Time. judgments.
3	2	2	2	1		1		3
1					1		1	1
1	2	2	2					1
1				1		1	1	1
1	2	2	2		1	1		1
1				1	1		1	1
3	2	2	2	1		1		
3					1		1	3
14	8	8	8	4	4	4	4	14

MORSE CODE.

Alphabet.

82 signs:

		Time judgments.
44 dot signs	— —	1 = 44
38 dash signs	—	3 = 114
56 dot intervals	—	1 = 56
26 dash intervals	—	3 = 78
		292

292 ÷ 26 = 11⅕ per letter.

16 words of 4 letters per minute.

64 × 11⅕ = 716 time intervals.

Add 16 × 3 = 48 end of words.

764 per minute.

764 ÷ 60 = 12¾ intervals per second.

82 signs ÷ 26 = 3⅕, 64 × 3⅕ = 202.

The question will now be asked, what is the system I propose to substitute for this? I certainly may say there is not one of the systems I have named, which are now in use, which fulfil *all* the conditions of our ideal system, for if there were, that would be the one system in use. All of them fail on some of the most important points when tested by the standard we have fixed.

MORSE CODE.

Visual Signalling.

The signaller's minute.
16 words 4 letters 64 letters.

Receiving.

Voluntary Brain	764	Time judgments.
	138	States of suspense as to meaning of signs as letters.
,,	48	States of suspense as to meaning of letters as words.
Eye	202	Light presentations.
,,	202	Dark ,,
Involuntary eye	202	Contractions of iris for sight; variable in duration.
,,	202	Expansions of iris for dark; variable in duration.

3 out of 20 pass = 15 per 100.
17 out of 20 fail = 85 per 100.

Approximate Dimensions of 3 Minutes of Arc at various Distances.

Distance.	Naked eye.	Binocular. Power 10 times.	Telescope. Power 25 times.
	inch		
1 foot	$\frac{1}{0\cdot5}$		
1 yard	$\frac{1}{3\cdot3}$	inch	inch
100 yards	$3\frac{1}{2\cdot6}$	$\frac{1}{3\frac{1}{2}}$	$\frac{1}{8\cdot0}$
1000 ,,	2′ $7\frac{1}{2}$″	$3\frac{1}{2}$	$1\frac{1}{4}$
1 mile	4′ $7\frac{1}{2}$″	$5\frac{1}{1\cdot2}$	$2\frac{1}{4}$
2 miles	9′ 3″	11	$4\frac{3}{4}$
3 ,,	13′ $10\frac{1}{4}$″	1′ $4\frac{5}{8}$	$6\frac{5}{8}$
4 ,,	18′ 6″	1′ $10\frac{1}{4}$″	$8\frac{7}{8}$
5 ,,	23′ 1″	2′ $3\frac{3}{4}$″	11
10 ,,	46′ 2″	4′ $7\frac{1}{2}$″	1′ $10\frac{1}{4}$″
15 ,,	69′ 3″	6′ 11″	2′ $9\frac{1}{2}$″
20 ,,	92′ 4″	9′ 3″	3′ $8\frac{1}{4}$′

Bright objects, divided by 3 minutes of arc, can be easily seen as separate.

Approximate Distances of Horizon.

Height	Feet.	Distance	Miles.
,,	10	,,	4·5
,,	20	,,	6·3
,,	30	,,	7·7
,,	50	,,	10·0
,,	60	,,	11·0
,,	70	,,	11·8
,,	80	,,	12·6
,,	90	,,	13·4
,,	100	,,	14·1
,,	120	,,	15·5
,,	150	,,	17·3

The description of the system I propose I must precede by a note or two of personal history.

Some one and twenty years ago, in 1873, an emigrant ship, the "Northfleet," was run down, I think, off Dungeness, and as the result of an exhibition of public feeling in the matter, a meeting was held in the City of London, presided over by the then Lord Mayor, Sir Sidney Waterlow, to consider the question of relief for the sufferers, and, most marvellous to relate, the question of how such disasters might in future be prevented was also to be considered.

Having said something at the meeting about my apparatus for saving life in shipwreck, I was requested by the Lord Mayor to act on the Committee. Certain experiments afterwards took place on the Serpentine, at which I was present. My duty was to observe a new system of signalling, propounded by Admiral Hall, the Chairman of the Peninsular and Oriental Steamship Company. Provided with a telescope, I endeavoured to read the signals, which were made by pieces of ground glass with a light in a lantern behind, with metal plates over the glass defining the shape of the numerals 1, 2, 3, 4, &c.

Spite of every effort, I was quite unable to read the signals at all, and, for some reason or other, could get nothing but a white blur, but the rays of reflected light which came through the ventilating holes in the bottom of the lantern were perfectly distinct and easily counted.

My observation of this fact was the originating cause of my attempts to improve signalling. The system proposed I call the "Stellar Abacus."

One of the first noticeable instincts of humanity is to count. As the baby lies in the cradle the fingers of one hand apparently count the fingers of the other hand. Animals possess the power of counting—crows, I believe, up to three, monkeys, I think I have heard, up to seven; sheep dogs must go further than that. Savages of the lowest type can certainly get up as far as ten. In fact, the race must have died out ages ago but for some numbering faculty in connection with the maternal instinct.

The system I propose does not tax human nature heavily. I simply ask that a man should be able to count nine, and have some knowledge of figures up to 44.

The well-known form of abacus in constant use throughout China for the most complicated calculations is before you. I take the four balls next the frame on my right hand, and I call those units. I take the next set of four, and I call those tens. On the screen in the large model of the apparatus you will see how the counting is worked. Continuous lines of dots cannot easily be counted, but if I divide them into groups they can be instantly counted by anybody. Therefore I divide my dots into two series of two, both the tens and the units, so that I get a "constellation" of eight stars in two groups of four, and on the top I put a larger star to serve all the purposes of a pennant in signalling.

Now I respectfully maintain that no observer who has once got sight of that signal can possibly mistake it for anything else what-

ever. No combination of ships' lights with shore lights, no accidental crossing of lights of passing steamers, could give anything like that constellation. And out of that constellation I propose to produce the whole of the letters of the alphabet.

The Chairman has the published description, and I will now show you on the large model how the alphabet is produced.

In the mercantile marine Mitchell's system is used, and the whole of the vowels are cut out for very obvious reasons. In my system, therefore, I have kept within the dark lines the consonants used in the present signalling book, and to get the vowels I make use of the tens only and the pendant.

This constitutes the association of ideas I have referred to in the ideal system, and in the limited time at my disposal I do not propose to discuss the mere mechanism of the system; but it is not essential that the vertical form should be adhered to when once the principle of the abacus is accepted. A horizontal arrangement with the tens on the receiver's left and the units on his right, the counting to commence outwards, each way from the centre, would serve equally well.

I merely wish to point out that there is a system which complies with nearly every requirement laid down, and I will assume that these discs which you see can, by the simplest of mechanism, be covered or uncovered in succession. I should like to draw your attention somewhat particularly to the words "in succession." You will note that it is necessary I should do this, on the ground of the abacus being the basis of the system.

Every light shown is one of an abacus group; there are no blank places. The lights or discs are shown in arithmetical order, and if a light were extinguished the fact would be at once known, and it would be seen that no proper signal was being made.

I am afraid there may, perhaps, be some disappointment felt that I have not brought before you a more elaborate apparatus, and shown you how these discs can be covered or uncovered; but as I am talking to men perfectly familiar with the electrical and mechanical agencies of to-day, they will see at once that if the principle is accepted there is no difficulty in devising mechanical arrangements to meet each particular condition.

I should like, if you will permit me, to go through the requirements once more with this proposed system before you.

I need scarcely point out, with regard to condition No. 1, that while you can see anything you can see this signal.

Every object diminishes by distance to a point, at least, before becoming invisible. With the assistance of glasses that point becomes a distinct object, and I have a testimonial here, taken from the catalogue of Mr. Steward, the optician to the National Rifle Association, in which the writer states that at 21½ miles he could distinguish a post 16 in. in diameter. If he could distinguish the post he could distinguish the daylight on each side of it. Therefore, if my discs were separated by 16 in. they would clearly be visible with that glass at that distance.

With regard to reflecting material I am disposed to recommend for diffused daylight and moderate distances—and the eyes of the reader must be regarded—dull gold or silver. Bright silvered reflecting mirrors will, under several circumstances, carry further; but a heavy black cloud passing over them might be reflected as well as other objects, and light thus lost. For distant signalling the screen can be used in a precisely similar manner to the heliograph; it is, in fact, a combination of nine heliographs in one. But these are matters for future experiment.

At night substitute lamps, electric or oil, for these discs; or, if distance permits, throw on to these discs a strong light from a single lantern, to be reflected to the observer. The first condition is therefore clearly fulfilled, and the screen is visible while anything else is visible, and the background is always right. The electric light solves all difficulties on board large ships, both for intensity and spaces apart. Whether it is better to concentrate the light in one lamp and reflect, or to use nine lamps or candles, is a matter to be determined in each case.

Then, as to the apparatus being "of the simplest character for entire efficiency." I have here some carpet nails with brass heads; I put them in and out of the board by their points, and I have a signal board which, with a good glass, is capable of being read at 1,000 yds. Let the size of the nails and their distance apart be increased and they could be read correspondingly further.

But I do not want carpet nails; some coins, say sixpences and a shilling, a morsel of wire and a bent pin, and I have another signal board; with a crown piece and eight florins a still more useful board.

A table-top, or a door from a cottage; the skirt of a black dress, with saucers and a plate, and a few nails and two slats from a fence to cover the discs, and a signal screen is improvised in five minutes that can be read at 2 or 3 or more miles.

With stones picked off the beach—white or black—and laid on the grass or the sand, I have another.

Give me a squad of nine men, and I can signal, on a clear day, 8 miles, if the receiver has a glass that will carry that distance, and, at night, any distance that lamps can be seen. For boat work, a few buttons hung on to the front of the coat, and turned or covered by the hands, or even the fingers themselves, would serve the purpose.

So that we fulfil our second condition, and it could be shown that, "with increased complexity of apparatus, it would be capable of the highest speed that can be sent." This is clearly so, for the only limit to speed, as before stated, is the temporary impression on the retina. A skeleton frame will serve as well as a board, if used with collapsing drums or balls, or the holes in a screen can be used.

Our third condition, "that it shall have a different sign for each letter of the alphabet, and each letter complete in itself," is, as we have seen, perfectly easy with the system I propose.

The fourth condition, as to the signal remaining unaltered and under constant observation until acknowledged by the receiver, is

also well covered by the system, whereas in the dot-and-dash system the waft of smoke or steam drifting across the signal confuses matters, and makes necessary constant repetitions.

An important point may be made here in the statement that ANY observer who can count can check the reading of the signals. It is conceivable that doubt might arise as to an important signal, and one or two officers, themselves untrained, could certainly agree whether the number shown was "14" or "33," or what not, quite irrespective of their knowledge of the meanings of those numbers.

The fifth condition stipulates that it shall be "easily learnt and remembered." At any age up to 40 I believe a man could learn this system in three sittings of two hours each; and I believe that up to 25 years a man could learn it and remember it in a couple of hours. And, in learning this, he has learnt the whole system of signalling for night and for day, and I hope for all over the world, not thirteen different systems to commit to memory, but one system, always available, and a rule to reconstruct the code if forgotten.

Seventh:—"That it shall be capable of use by anyone possessing a copy of the code." It is hardly worth while after the lecture trying the experiment, but if two of the audience will take these—almost my last copies of the code—they will, by the assistance of the diagram, be able to read any alterations I may make in this signal.

The eighth asks that we shall be able to transmit secret signals—that is, signals not *seen* by anyone but those for whom they are intended. This will be perfectly possible. All that is necessary is to have wings or sides to the screen, or tubes to the different lights, and, as these restrict the field of the rays, so the secrecy of the signalling is increased.

A proposition was made some years ago by a French astronomer, an account of whose experiment I will read:—

> "*New Light Signal.*—M. Laussedat has invented a light signal which can be seen only by the person for whom it is intended—that is, the one who knows its position. Suppose a telescope directed, in a station in which one is situated, towards another to which one wishes to send light. Place at the focus of the telescope a diaphragm with very small aperture—such that the field of vision includes only the building (tower or the like) in which the observer is. Remove the eye-glass, and put behind the diaphragm, in the axis of the telescope, first, a convergent glass, then a luminous source, the conjugate image of which, produced by the glass, falls exactly in the opening of the diaphragm. The luminous bundle will then fall on the building included in the field of vision, and the light will be invisible to any that are out of this field. The distant observer will perceive this bundle in full. He will see the object glass of the emitting telescope illuminated throughout its surface; and the greater the diameter of this the farther will the signals be perceptible. A petroleum lamp will give signals visible to the *naked eye* at 20 miles."

Our ninth condition is "that it shall involve the least possible movement." The exposure of the signaller in warfare has already been commented upon. Whether this signal board is fixed at the masthead and worked mechanically, or worked with electrical apparatus, and the discs mechanically covered, or the lighting current is turned on and off, the flexible shafting used for drilling could be used to turn a cylinder with discs or a series of perforated screens, the actual transmitter can be entirely concealed and protected—a condition of things utterly opposed to, and in good contrast with, the the flag-waver, whose person constitutes the post on which the flag rotates.

The tenth :—"That no distance at which anything is visible shall prevent its use." In the case of so-called double stars, to the naked eye there is but one star, as in the case of Eta Coronæ, Gamma Leonis, Polaris, and Beta Orionis or Rigel. All these split up, with glasses of more or less power, into distinct stars. While in the case of Epsilon Lyræ the glass reveals a double double-star, and in Theta Orionis we find a single star splitting, with sufficient power, into seven. Assuming anything to be visible by glasses of any power, the discs of this system will be visible. All that is necessary is to increase the intensity of the light, and the distance between them; so that it would, under favourable circumstances, and at sufficient height above ground, be possible to signal from any distance that might be needed.

Col. Keyser states that the heliograph in South Africa has carried 42 miles, and the limelight the same distance, while by moonlight 9 miles has been covered in India; and that it has also been worked successfully by reflected artificial light.

The eleventh condition :—"That the sender and receiver can continue its use without excessive mental or bodily fatigue."

I think the mental fatigue of reading this one only system of signals, with the transposition into numbers and then into letters, must be very much less than that experienced by a man who has to observe every letter by three or four momentary flashes, with a memory encumbered by several other systems of flags, waving arms, and the like; while flag-waving with a very large flag is a very fatiguing business indeed, and, after an hour with the lamp, the eye gets dazed and dull almost to failure to read.

With regard to facility in sending, an electric keyboard for vessels and fixed stations on shore would remove both difficulty and fatigue entirely, and with a code a whole host could be used at once.

Thus, for visual signalling I claim to have set up an ideal system, and to have devised one which meets all its requirements.

With regard to aural signalling, which is the twelfth and last condition enumerated, I claim that it is perfectly possible to use this system. The majority of people are so constituted that anything in the nature of a tune is more easily remembered by them than anything else. The use of the bugle in the army is an illustration of this fact.

On the screen I have shown the musical signs for this code; and I should strongly recommend that during tuition the musical code was used, as far as possible, whenever the visual code was used, so as to

indissolubly associate the two things in the mind of the learner and thus educate the ear and eye together.

For the pennant I have one note, say, for instance, the lowest C of the natural scale, indicated on the G clef. For the tens, the middle C (third space); and for the units, the G on first space above the stave.

Now, these sounds, given according as the code required, would make a sort of tune, which, constantly associated with the letter, would enable steam whistles, electric alarms, sirens, or bugles, to spell out the note.

In the case of sound-proof fog banks—a well-known occurrence on these coasts—I believe that the condensation of steam escaping into the sea through differently formed apparatus would produce vibrations which could be used for signalling to a vessel provided with a submerged microphone and connections. The vibrations of a bell on Lake Geneva have been heard (felt?) at 9 miles, and it is also certain that the sounds of the waves on the shore, and against the walls of icebergs, will cause vibrations in the sea which might be heard and distinguished by a similar agency. The throb of a screw beating the water *should be* a signal of danger to approaching vessels.

You point out that I want *three* whistles where the other systems want *one*. But I point out that I will find you 50 men who can read the three whistles of different tone, to your 10 men who can read the dot-and-dash blasts in one tone. Any trained boy bugler could learn the whole code in a few days' practice.

I may here remark that, recognising the very great difficulty of localising the origin of sound in fog, I have devised an apparatus by which the source of sound can be determined within some two or three degrees. The apparatus consists of, as you see, a pair of ear trumpets with very narrow mouths, covered with hair to keep out all vibrations except those directly in front of the mouths. In the rabbit, the hare, the donkey, and the horse, Nature has provided an apparatus of precisely similar kind, and for similar purposes.

I have now completed the comparison of the system I propose with the standard, and I think it will be admitted that it has fulfilled, as far as possible, all the conditions laid down.

If we consider what impression would be produced on the minds, say, of the Directors of the London and North-Western Railway Company, or the Board of Trade Inspectors, by a proposition to replace their present mode of signalling, by any of those at present in use in the navy, mercantile marine, or the army, we can form some judgment as to how far it is desirable to retain them for uses in every respect as urgent and important as those for which the railway system is now in use.

The likeness of my system to the railway system has led to the question being put to me whether I did not derive it from the railway signals. But, as I have already informed you, this is not the case.

I may venture once more to draw attention to the immense im-

portance of two points. First, the desirability of *one single system for every kind of visual and aural signalling all over the world.* Second, the desirability of extreme simplicity, so that almost all the members of a crew, or a regiment, or even the passengers of a ship, should be able to send and receive signals.

With regard to collisions, I wish to point out that it is the absence of means of easily communicating what each commander *means to do next* that is responsible for the greater number of these calamities. What each is actually doing is in most cases quite clear to the other. What is wanted is an answer to the question, "What are you *going* to do?"

To those who are familiar with the facts of the "Victoria" collision, I would suggest that they ask themselves this question—"If those two vessels had been connected by a telephone, would that accident have happened?" The answer must be, "It could not have happened." Therefore I say that just in proportion as you can increase the facility and rapidity of signalling, just in proportion will you diminish the liability to accidents of this class.

In conclusion, I think I may say that I have made out a fair case for investigation. Up to this moment I have worked entirely alone, and, but for the opinions expressed by the late eminent astronomer, Richard Anthony Proctor, without the slightest encouragement. The time was not ripe for inquiry when I designed and published my plans; I think it is now.

The verdict pronounced by you to-night may condemn the scheme to a continuance of the obscurity in which it has grown, but that verdict cannot affect the ultimate settlement of the question on the bases I have laid down. The world waits for a system of visual signalling common to all nations; that system must be one for night and day alike; that system must be easily learned; the signals of that system must remain under observation till understood and acknowledged. These three points are fundamental, and no system that violates them can live when once the public mind of this country becomes awake to the importance of the question. And there are signs that the public mind is awaking; let us hope it will awake before it is too late.

Captain BOWER *(Oxford Light Infantry):* My lord and gentlemen, I have been very much interested in hearing of this new instrument for visual signalling; but, regarding it from an entirely army point of view, I should like to know how long it takes to signal one word. Judging from the example shown before us just now, each letter has apparently to be signalled and acknowledged before the next letter is sent; in which case, if we compare it with any of the signalling apparatus now used in the army, we should find, I think, that the whole message would have been sent by the present operator, under the present system, and received before even the preamble of the message would have been acknowledged under the system suggested by our lecturer. As regards the difficulty in learning the Morse alphabet, I think the lecturer has somewhat overrated that. Speaking from experience of a class of signallers which was formed at Aldershot nine weeks ago, I find that out of 21 officers who joined that class, knowing very little about signalling, the whole 21 passed, and nine were able to pass in reading at very high rates, that is, rates quicker than 16 words a minute. Four or five of them read at the very fast rates of from 18 to 20 words a minute, which I think shows that any

ordinary person possessed of good eyesight should be able to learn the Morse code without any difficulty in two or three months. This is not by any means an unusual occurrence. I think Lieutenant Lethbridge, who has had some experience with Volunteers, will say that he has found that the Volunteers learn signalling quite as easily. I should say, also, for army signalling that the instrument brought forward to-day does not appear to be a very portable one, because the lecturer tells us that for different distances you would require the signs to be further apart; so that an instrument like the one exhibited, which might do very well for one or two miles, would be useless at 10 or 12 miles. Again, when we get the further distances at which we have not the slightest difficulty at present in signalling with the limelight or the heliograph, we should apparently require with that instrument a very large framework to carry all those lamps or reflectors; and it is a question whether this apparatus at 25 miles off would be visible, unless those lamps were at very great distances apart. Possibly, also, the clouds might obscure one or two of these reflectors, while the others remained visible, which would entirely alter the conditions of accurate working. As regards the disc shown on the rifle, I think that one large flag is visible for quite as long a distance; this large flag we read easily with the telescope up to 12 miles; but I doubt if we could see that disc with the same telescope at anything like that distance.

Lieutenant W. S. C. Lethbridge (Grenadier Guards): My lord and gentlemen, Lieutenant-Colonel Harrison has laid before us this afternoon a scheme of signalling, and he has mentioned that it is applicable to military signalling. Now, the first thing that military signalling requires is absolute portability; and I ask you, gentlemen, does this system answer that requirement? To my mind it does not. We have at present in the army one of the most absolutely portable systems that can be devised combined with the great ranging power and absolute ease of working. Now, I ask with the kind of instrument that you see here, with that disc, with the lamps, and all the apparatus required, whether it is equal to our own system in that regard? Besides, where you have this number of bolts and levers to work the slides up and down, it seems to me that they are very likely to get out of order, thus enormously increasing the risks of breakdowns. That has always been my experience with any apparatus of that kind. Lieutenant-Colonel Harrison talks about light and reflected light. I should like to ask whether he has ever tried an experiment with reflected light. I have done so, and my experience has been, so far, that it is a most perfect failure. Light is one of the most difficult subjects we have to deal with, and is very slightly understood. What we at present require is an absolute portable light, of great range and penetration, of easy manipulation, and capable of piercing fog and mist, discerned, and easily worked; in fact, making us signallers to a great extent independent of the weather. In the present instrument before us this afternoon, we have five lamps in a row. I cannot see how he can well work each instrument without the aid of three men, and, what with a man at a telescope, another employed in writing down the messages received or sent, a properly-equipped station would require quite a number of signallers—far more than we could spare. The lecturer has referred to the difficulty of the Morse code. I am afraid I don't agree with him in that respect. He substantiates his fact by referring to an examination of Royal Engineers, quoting the figure of merit of 98 per cent. as something extraordinary. I can only assure him that we have done better in the Home District; the average for the last three years of flag reading is 100 per cent., and that of the lamp as 98·51. I cannot help reminding Lieutenant-Colonel Harrison that some years have elapsed since the Royal Engineers have been examined, and that since then signalling has made a great advance in speed and accuracy. I quite agree with the lecturer, that a signalling instrument should be invisible to anybody except the sender and the receiver, and if he can give us any further information on that point it will be extremely interesting. He mentions the new light signal of M. Laussedat. I should much like to hear further details as to its construction and manipulation. Finally, I must ask the lecturer whether he has ever put his instrument to a practical test in the field.

Major-General W. Lambert Yonge: My lord and gentlemen, I think we ought to thank Lieutenant-Colonel Harrison for bringing his ideas before us. There is

great tendency, of course, to stand still when we have arrived at an apparently satisfactory result, whether it be in signalling or any other military subject. Therefore, whatever the opinion of this meeting may be as regards this particular invention, whether we think it practicable for the army or the navy, whether the apparatus is suitable or is likely to prove too cumbersome to be of any practical use, we ought to welcome the present attempt at pointing out the defects of existing systems and the suggestions of the lecturer, which appear to him to be improvements. I sympathise with him in this attempt, because, as may be known to some gentlemen here, this is not the first time that I have myself mooted my opinions in this theatre on the matter of signalling. Inventors, however, have a very poor chance when there is an established system that is at all satisfactory. Now, it would not be fair to the present army signalling staff to say otherwise than that they have a very complete mastery of signalling up to a certain point. They have done wonders considering their very complicated system, based upon the fleeting "elements" with which they start, viz., the dot and dash of the flag, and of the corresponding night apparatus. But there is no doubt whatever, as the lecturer has said, and others before him have said, *it is not an easy system to learn, and having been learnt it is not an easy system to remember.* It is only necessary to refer to the official Instructional Handbook to find that the authorities do not pretend that anybody can learn the *alphabet* under, I think, 15 to 20 days, giving five hours a day. The whole course, I think, takes some considerable time; the last speaker said two months, but I believe it may be done in perhaps six weeks. The handbook says that the instruction of the men should occupy from 40 *to* 50 *working days*, according to their intelligence, and that it should be without interruption, which means that a man is to be taken off his other duties, and to give his undivided attention to this instruction alone, and his "efficiency kept up by frequent practice." I saw a memorandum issued last week by the General Officer commanding the London District as to the signalling on a field day, from which it appears that some volunteer presented himself as an efficient signaller, who was found not to be acquainted with the Morse alphabet. Now, this individual could hardly have come forward as a signaller unless he conscientiously believed that he was acquainted with the A, B, C of the official system, and which he had doubtless learnt at some time or other. I think that incident affords a proof of the fact that the alphabet is very difficult to remember. Lieutenant Lethbridge said the first consideration in the case of signalling is to have a portable instrument. I do not think that is the first consideration, although it is a very important one. Experts in foreign countries—and I have here extracts from German and French writers—say that the first thing is *accuracy*,[1] and that no system is worth speaking of that is not accurate, and whose signals cannot be inspected at leisure in something of the form that the present apparatus presents to us; and they also draw attention to the fact that the signs of the Morse system are so evanescent that it is extremely difficult to insure accuracy. The very smallest obscuration, or a loss of attention for one moment from the eye-piece of the telescope, may drop an important element from each letter, and, consequently, of each word, and this may entirely mar the sentence. Therefore, although it is important to have an apparatus fairly portable, that is not the first necessity. The first necessity is that it should be absolutely accurate, so that there shall be no possible mistake about it. I think too much is attempted in the way of what we should call portability in apparatus connected with signalling. A man is not so very weak that he cannot carry a few pounds in the shape of an apparatus, and there are at least three men to every signal party available for carrying the apparatus. If you require certain results in other branches of the Service, you do not incur the risk of losing them by having the apparatus insufficient for the purpose. We should never have powerful field guns if considerations of this kind were allowed to override the necessity for a sufficient supply of

[1] "It must be remembered that speed of communication by signal is of no value if mistakes occur. . . . . Rapidity should hardly be attempted until absolute certainty has been first secured. Nothing in signalling must be taken for granted, and repetitions of words or sentences about which the slightest doubt exists must be called for."—"Manual of Signalling," p. 69.

ammunition; nor could an Engineer train carry pontoons, which are more or less cumbersome. The fact is that here, at least, "the end justifies the means." If the game is worth playing, we must not grudge the necessary "candle." The lecturer enumerated, at the commencement of his lecture, some 10 or 12 conditions which he considered essential to the efficiency of any system, and he went through them *seriatim*. He said that his ideal system has not been attained, we have hardly arrived at it yet. This is so, especially with regard to the last item, viz., one that will convey a signal to your friends but not to your foes. They are all very fair conditions, but he has compressed them in the last paragraph of his lecture into something like three. He says, "The world waits for a system of visual signalling common to all nations; that system must be one for day and night alike; that system must be easily learned; the signals of that system must remain under observation till understood and acknowledged. These three points are fundamental, and no system that violates them can live when once the public mind of this country becomes awake to the importance of the question." Captain Bower objected to the requirement put forward by the lecturer that the signal should be repeated. Of course it is an advantage when it can be repeated; but, as a matter of fact, it is not repeated in the army system because it would involve an intolerable occupation of time to attempt the repetition. The message in all conscience is long enough on its way now, and in one of the German criticisms of the Morse signalling it is pointed out that it is most wearisome to the eye of the operator to attempt to repeat the signals, and that is the reason why we do not repeat them.[1] In a case where repetition can be done without fatigue and without difficulty, there ought decidedly to be repetition. I, therefore, think the objection made to this particular system, that it permits of easy repetition, is hardly a valid objection. All I think the lecturer wanted to insist upon was that it should be visible for any length of time that circumstances might necessitate. Now to come to a matter rather personal to myself. The lecturer says, "The world waits for a system of visual signalling." I do not know why it should wait. Twenty-three years ago I suggested in the pages of the professional journal of the Royal Artillery a system of signalling which fulfils all the conditions insisted upon by the lecturer. This paper, in the ordinary course, reached the Vienna Headquarters' Staff. The result was, being convinced that it was a good system, they set to work and made the apparatus, and the next year it was adopted as the official system of visual signalling in the Austrian Army. They abolished the "flag-wagging" from that day to this, they have had no other official system than that which I proposed in the Proceedings of the Artillery Institution 23 years ago. It still holds its own, and in a recent publication of our own Intelligence Department on the Austrian Army the whole details of the system are given. All I will say about the system now is that I will undertake to teach it to anybody in a quarter of an hour. I once had the good luck to get a detachment of Guards placed at my disposal at Frensham, when Prince Edward of Saxe-Weimar was commanding the division there. At my request he gave me half a dozen squads from the Guards. I began to explain the system to them, and had hardly been speaking five minutes when they said they understood all about the system, and did not require any further instruction, and the next day they signalled with it. I say this in the presence of some Guards officers, and it either points to the extreme aptitude of the Guards to learn a new system or to the simplicity of the system itself. In 10 minutes you will learn the whole system, and you cannot forget it if you try. It is absolutely accurate; you can look at each signal as long as you like; the apparatus is portable, and it is better at night than by day. The distance at which it is visible depends upon the quality of the telescope used, being from 8 to 10 miles in the daytime, increased to 12 or 14 at night. The apparatus weighs about 20 lbs., and costs about 10*s*.,

[1] "It must always be borne in mind that the sending and receiving of a message, simple though the operation may be, requires no ordinary amount of attention from every man engaged therein. After a message is begun, the strain on each man is considerable, and any delay interrupts the concentrated attention of the whole party, and *it is not easy to restore it*."—"Manual of Signalling," p. 73.

besides the lamp. I do not know what success the Volunteers had the other day in their attempt at signalling for a distance of 100 miles. There were 28 stations. Probably each station had two parties, each party had three men, and if they succeeded in carrying the signal from one end of the line to the other with anything like accuracy, successfully delivering the message which started at the other end, I think they deserve every credit which could be given to them. On the other hand, I should like to be assured of the fact as to whether it was successful or not. When tried on a less ambitious scale it was described in the reports as somewhat unsatisfactory, and it was pointed out that a General officer who trusted to such inefficient signalling was simply trusting to a broken reed. I have no doubt this was a very accurate description of unsuccessful signalling; but, at any rate, it is a little disheartening after a good many weeks' attention to signalling that the final result should be *nil*. I think, therefore, if the Volunteers, who are not bound down by the same strict conditions as army officers, are thinking of going into signalling, they might, perhaps, turn their attention to the clock-vane system which, as I say, is adopted throughout Austria. As far as I am concerned, I shall be happy to render any assistance in this direction, because, as I say, they do not seem to be under the strict conditions which apply to army officers, and, therefore, if they are free to make any experiments on their own part, I shall be very happy to aid them in testing the system; and I believe that permission would readily be accorded to the auxiliary forces to try their hand at an auxiliary system of visual signalling capable of supplementing the existing army system.

Captain MAUDE: My lord chairman and gentlemen, I was signalling instructor some years ago in India, and should therefore like to say one or two words. It struck me on reading the lecture that Lieutenant-Colonel Stewart Harrison summed up the whole case for signalling, and pointed out the general principles on which the thing is based with exceptional clearness. As far as my own experience in teaching signalling goes, it is one of the most difficult things in the world, and it seems to me that it is an absolute waste of time. We used to have six weeks, now it appears they have three months for learning the system. The fact is now that we seem to have about 25 per cent. of the British Army out on the commons or the hills all day long wagging flags, and they do nothing else. It is certainly quite possible to have a signalling system, as Major-General Yonge has told us, that everybody can learn in a few hours, and why on earth we should waste weeks about it is more than I can understand. As to the matter of portability, years ago we used to have a screen 15 ft. square for signalling by the Morse code. It was used because it was found more convenient than the flag, and in the daytime it was more convenient and clearer to read. I imagine that the particular system that we have before us will only be used under like conditions. As regards the portability of the thing for ordinary signalling between regiments and companies and so on, I think Lieutenant-Colonel Stewart Harrison explained that you need simply take out that disc, which weighs even less than one of our small flags, and is quite as portable. Something was said about reflected light and what we know about optics, because the heliograph is only reflected light when you come to think of it, and the Laussedat invention mentioned is, I think, the identical one in use in the French Army. The light is reflected through a prism and out through the lens, and when you get the exact line of that instrument it has a very extraordinary effect. You simply see a bright glowing star where you never expected to see one, and you only get it in a very small arc indeed; if you do not know the exact spot to look for it you cannot find it. The standard of signalling changes very much. The difficulty is to know how you are to set a standard as to what sort of messages are to be sent. If you take the ordinary signaller, even after 6 weeks' training, he will read any ordinary sentence or even big words; but if you send him an awkward message with a few foreign words, addresses, names of towns, and so on, with which the men are not acquainted—the sort of thing which would happen in the case of war—I say that such a message, if sent through five stations, will rarely come out correctly at the end, no matter who reads it, and for such purposes we cannot put the smallest confidence in any men except trained telegraphers. As regards repetition, it used to be the case—I do not know what it is now—when signalling by cypher, we broke

it up into groups of three, and repeated each group, which would not be very much worse than repeating each letter.

Captain HANBURY: The lecturer lays great stress upon having only one system of signalling. Now, I want to know, if you abolish the Morse system, how are you to get over the difficulty of signalling without some *small* apparatus. You might have a small reconnoitring party going out which could not take an apparatus with it, and if you had to take these discs to fix on to the muzzle of the rifle, you would have about nine men with each party instead of only having one signalman with a flag, or a man waving his cap, and if each company of a battalion had a party out you would want 72 men. I do not know, if you abolish the Morse system entirely, how you are to get over that difficulty of signalling without a cumbersome apparatus.

Mr. DALLMEYER: The lecturer, my lord, has been good enough to call upon me with regard to one question raised, viz., the visibility of this system. Of course, I do not presume for a moment to say anything about the physiological or psychological reasons in favour of this system, but with regard to its visibility, I may say that an object glass, carefully corrected for both spherical and chromatic aberrations, will give a separating power equal to $4\frac{1}{3}$ secs. divided by the diameter of the object glass, so that, with regard to distances mentioned, there should not be any difficulty whatever in separating the white discs or the lights as the case may be, or reflectors, in using a telescope of very moderate dimensions even at long ranges. Lieutenant-Colonel Harrison, in asking a further question, said (and in that I believe most will agree), that it is very much easier and less fatiguing to see an image projected on a screen and viewed at the ordinary distance vision than it is to look through an instrument to observe the object direct, as through a telescope. The process of telephotography, an invention which I introduced a short time ago, would render these signals sufficiently *large* to be visible upon a screen. Those who are interested in photography will see the only one drawback that there is to it, for there is no reason whatever why an object, such as Lieutenant-Colonel Harrison mentioned to me, 50 ft. square, to be represented by an inch in an image, could not be accomplished by this process. In the ordinary way it would require a telescope some 88 ft. in length; by the process of telephotography this could be reduced to some 3 or 4 ft. But when you come to consider, as practical photographers, that probably the minimum of light necessary to see such an image would be perhaps F/64, you will appreciate what that means; it would mean that, to get this 50-ft. square an inch large at a distance of 10 miles, an object glass of 18 in. diameter would be necessary for adequate brilliancy, so that really for the purpose in hand, the system mentioned by Lieutenant-Colonel Harrison would not answer. The photograph he referred to of Mont Blanc was taken at a distance of 56 miles, but with a prolonged exposure. This instance was not one involving the necessity of an easily *visible* image; the chemical image took some 5 mins. to form.

Lieutenant-Colonel STEWART HARRISON, in reply: I have nothing to complain of, my lord, in regard to the very friendly spirit of, I won't say my opponents, but of those who are anxious to have this matter investigated and fairly tried before it is finally condemned. With regard to the difficulty of the Morse alphabet, we find that even with the officers, men of higher intelligence than the ordinary rank and file of the army, only nine out of twenty-one managed to get through.

Captain POWER: Not get through; they all passed, but the others were at a rather lower figure.

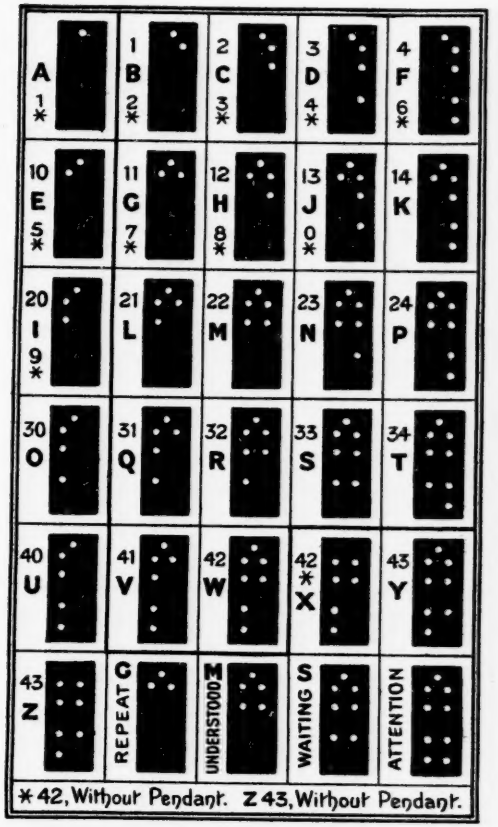
Lieutenant-Colonel STEWART HARRISON: The whole of the officers passed, but undoubtedly Colonel Keyser did say that after selecting the material in the various regiments (most fitted to make signallers) only three out of twenty managed to pass the requisite standard, and if that is the case in the army where they only have to know the flags and the lamp, what must be the condition of the navy, where, in addition to knowing these, they have to know so much else? I believe, if you watch carefully the manœuvres that are going to take place in July, and if we could possibly get a Member of Parliament to have an accurate Return made and have the signalmen's log books laid upon the table of the House, I think you would find a revelation with regard to the day and night signalling of the

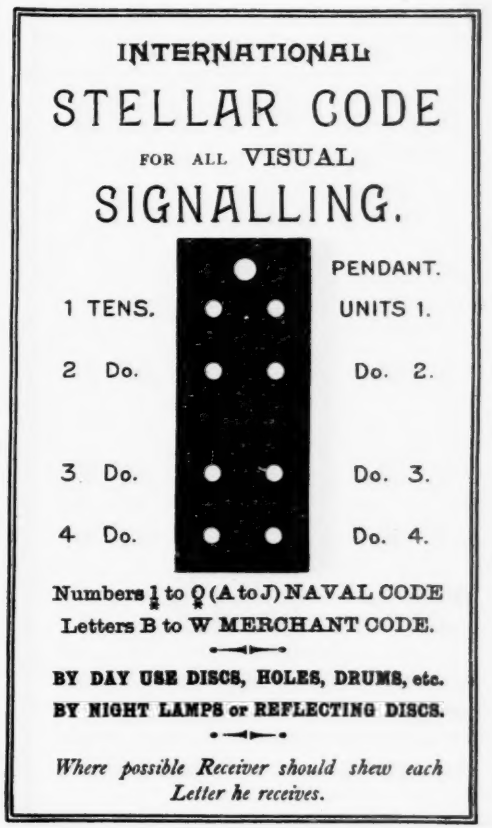
navy that would somewhat startle you. As a matter of fact you have no thoroughly good system at all. Your drums will not work at the speed necessary to give the Morse code accurately. Your lights flash up in the air or on the water; they are stopped by intervening objects, and you have constant errors and repetitions necessary. If there is one place in the world where you want an improved system of signalling it is in the British navy, and you will never have that improved system of signalling while you have flashing lights either for night or day. With regard to the other observations. As to the limelight, reflected light, and the like, that is purely a question of efficiency. You cannot signal without light. I never pretended to signal in the dark. If you do not get light enough with that screen on the wall you must increase it. With regard to its portability, I may say that these screens are made in wood, but when you bear in mind that a sheet of aluminium can be stamped and an accurate apparatus can be made by which the whole weight of the screen to be visible at 3 or 4 miles could be reduced to something under 7 lbs., I think you will not have much to complain of on that score. You must occasionally sacrifice portability to accuracy, even in signalling as in all other things. You want a portable instrument, but you also want one that will be useful. Then there was another point. I do not know what to say with regard to Major-General Yonge's system. It is a competitor with my own, but I think it has defects for use on board ship which mine has not. I begin with less than a dozen (nine in fact) stones laid on a sandy beach, and I am ready to go up to electric lights of 2,000 candle power if you like. The system is one and the same. If you have not daylight enough you can take and work your limelight from up a dark doorway and see it for nine miles in the daytime. We do not want to do that in broad daylight, but on a dull day when there is no other light possible you might signal by artificial light where the ordinary conditions of daylight fail. I should like to thank Mr. Dallmeyer for attending here and for what he has said. An important point is this, that if you can only get your signalling screen to show on the plane of picture at the ordinary focal distance you have gained a great deal. The perpetual gazing with one eye through the telescope is one of the most fatiguing and harassing operations. Any man who has watched the shooting at a range will know there is nothing more desperately fatiguing, nothing which he feels more unsafe about, if a shot is challenged, than his view of the target. He gets so dazed with the distance and the endeavouring to focus the eye to the distance that many a man would rather retire from giving a decision as to a disputed shot and refer it to the target men (the markers) than to state what he himself thought about it. With regard to the camera, there can be no mistake about a fixed signal. The camera filters out everything but that, and you sit down before it, and see the signal exactly as if it were in print. Presently I hope some of you will try this, and you will be astonished at the charming clearness with which these little dots come out. There can be no mistake in the counting, because they change as easily as the change from one letter to another in reading print in a book.[1] I have to thank you very much for the consideration you have shown me. I have to thank you, my lord, for presiding on this occasion. I do trust that what has been said will lead to a reconsideration of these matters before some catastrophe urges upon us the extreme importance of looking before we leap. We have stuck to the Morse system for 30 years. It has left us in the navy without signalling of any proper kind at all. It has left us in the army with a number of discontented men and with an extreme difficulty of filling up the ranks of signallers from the class of men from whom only they can be filled. I trust that this system will be altered, and that one universal system will take its place in the world.

The CHAIRMAN (Lord Belhaven): Ladies and gentlemen, I am sure you must all have listened to this extremely interesting lecture by Lieutenant-Colonel Stewart

[1] I had it on my notes to say that I thought the accuracy of fire of large guns would be increased by use of the telephoto camera for sighting, bringing the object and the foresight on to the plane of picture at the ordinary focal distance. If the light were not sufficient a beam could be thrown on the vessel from the search light of the firing vessel, and that long range rifle shooting might be improved in a similar manner.

Harrison this afternoon with the greatest pleasure. It has opened up a considerable field in the general question of signalling. I think it is very necessary that we should separate in our minds the signalling necessary for military from that required for naval purposes, just as we do not wish to intrude the signalling of those Services upon the railway companies who have a special thing to do. We can hardly expect that Lieutenant-Colonel Harrison's system of signalling will ever find very much favour in the army, now that the Morse signalling has gone on for a sufficient number of years to be extremely perfected. I did gather from his remarks that he very little understood the perfection and accuracy to which the present system of army signalling has been brought, and therefore I brought with me the Army Orders dated the 1st March, 1894, with reference to the signalling of the Regular Forces, and I have the similar Returns for the Volunteer Forces. I will not detain you at this period more than to call attention to the fact that taking the infantry battalions, of whom 70 were examined with the large flag, you have to go a long way down the list before you find men who could not read 100 per cent. of their letters correctly; certainly the sixth in the rotation lost a letter and the twelfth were also a small decimal under 100. The rate of sending was 10 words per minute. The rate of sending with the small flag is 16 words per minute, and you get to the thirteenth before you find any corps that did not read 100 per cent. correctly; and the limelight is almost as accurate. The percentage is 99·57 and 99 for a long way. I personally have had a great deal of experience with the telegraph and signalling, having had charge of the telegraph troop during my service for four years, and having also had charge of the signalling and telegraphs during the Zulu War. With that experience I know that a letter lost now and then in the long day's work means absolutely nothing. It is no worse than a misprint which you find in your newspapers. Such an error is easily understood, but if it makes nonsense the word is repeated. Therefore, I say the accuracy which we have attained to is excellent, and we also have rapidity. Lieutenant-Colonel Harrison has not told us how many words a minute he would have signalled at a distance of 5, 7, or 10 miles, as you can do with the large flag. Therefore, I do not think, on the point of rapidity, that he is likely to convert us to the use of his apparatus in the army. As to naval signalling or signalling from fixed stations, I have not the same experience, although I have had some opportunities of seeing it, and I do think that there is something very excellent in this system of spots, if applied to incandescent lamps. Incandescent lamps, as you all know, take some time to become brilliant—an appreciable portion of a second—and a certain time to go out, and the result of that is that Morse signalling with incandescent lamps is very slow work; I believe not more than four or five words a minute can be done. But, on the other hand, if you can light up a certain number of signals all at once by incandescent lamps in that form, I can imagine that you would read a much larger number of words per minute. I have not heard how rapidly it can be done, but it seems to me a system which would lend itself very much to that. I did not gather from the lecturer how he would use his system for sound, but I have no doubt that he has some system by which the different notes may indicate the different positions of the lights. I also would like to tell Captain Maude that I have seen some signalling done for practice at the last Easter manœuvres in my own Volunteer brigade, in which the long names of Zulu chiefs and South African places—made up of most incongruous consonants, beating even Welsh words—were very carefully and accurately transmitted from station to station; therefore, I do not think it is fair to say that the signallers of the present day can only spell words of three letters. I have only one other duty, and that is to propose a hearty vote of thanks to Lieutenant-Colonel Stewart Harrison for the very interesting lecture he has given us.





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FOREIGN SECTION.

RECENT PROGRESS IN MARINE MACHINERY.

Translated by Staff Engineer T. J. HADDY, R.N., from the article in the "Rivista Marittima" by NABOR SOLIANI.

(*Continued from R.U.S.I. Journal for September*, 1893, *No.* 187.)

THIS question of the arrangement of the air-pumps has been fully treated of by Mr. G. W. Dickie, of San Francisco, in the excellent paper entitled "Auxiliary Machinery of Naval Vessels," read by him at the International Engineering Congress at Chicago. Mr. Dickie is decidedly in favour of air-pumps worked by the main engines, more particularly from the difficulty experienced in making them work regularly and in harmony with the varying conditions of speed, &c., when they have their own motor. Whilst in the case of most engines an increase in the speed of the motor, through a rise in the steam pressure for example, causes an increase in the resistance to be overcome, and there is very soon a re-establishment of equilibrium between the motive power and the resistance; this is not so in the case of the air-pump engine where an increase of steam pressure produces a constantly accelerated speed of the motor, which is limited solely by the increased resistance to the flow of steam in the motor with the increased speed; on the other hand, a decrease of steam pressure produces a constantly decreasing speed until the engine finally stops. Mr. Dickie also treats of the various methods of avoiding this difficulty, which are coupling the air-pump with the circulating pump, or by a special distribution of steam to cause an increase of back pressure in the cylinders of the air-pump motor with the increase of velocity. This is well carried out in the air-pumps of the "Blake" type, but at the expense of a large consumption of steam.

The coupling of the air and circulating pumps is in use in our navy on board ships of the "Tripoli" and "Folgore" types, and the results as regards regularity of action are satisfactory enough. In the French Navy they have gone still further, and in some of the smaller ships have adopted an independent auxiliary engine for working the air, circulating, and main feed pumps together. This arrangement, which has the advantage of simplifying and reducing the number of the auxiliary engines which require attention, appears to me worthy of much consideration, although there are good authorities who consider it inconvenient to combine too many important functions in one apparatus. This is true, but it is also true that

instead of a number of small auxiliary engines, we have a single powerful machine much easier to attend to and keep in order. Mr. Dickie does not mention the idea already carried out in our navy of working the auxiliary air-pump by the circulating pump engine as an auxiliary to the principal air-pump, although the same idea is to be tried also in the American Navy. In their general design it may be said that air-pumps have changed very little from what they were originally. Simple acting vertical pumps with valvular plungers, which were introduced, one may say, with the first marine vertical engines, are now generally and almost exclusively used in modern marine engines, and almost unaltered. Only in the details have slight improvements been introduced, and these are even now antiquated. For example, in the merchant service air-pump valves have been for a long time preferably metallic, because they remain unaltered, and work well longer than valves of indiarubber or fibrous material. In war-ships also the use of metallic valves is extending, except for very quick-working engines, for which indiarubber is by many considered preferable. For example, the engines of the Shichau type, which are so extensively used in our navy, have air-pump valves of indiarubber. One essential point, sometimes neglected in the design of air-pumps, is that of facility for the examination of the valves; this is generally obtained by means of a door fitted in the sides of the pump cylinder itself.

The use of the air-pump as a means for pumping out the ship in case of leakage or accident is being discontinued on account of the complication of the pipes, &c., which it entails. It is preferred to have an extra circulating pump on board, as it furnishes a more powerful means of pumping from the bilges, easy to handle, and which does not necessitate slowing down the main engines when it is required for use; this gives the advantage of duplicating the circulating pumps, assuring continuity in their action, so important for the main engines. Air-pumps, which in the old jet condensing engines absorbed from 5 to 7 per cent. of the power developed, absorb very much less in the modern triple expansion engines (about 2 per cent.) in virtue of the increased efficiency of the engines themselves, and still more by reason of the surface condensation employed, which throws much less work on the air-pumps. This low coefficient, however, is referred to the full speed power of the main engines. At reduced speeds the coefficient of power absorbed by the air-pumps is much greater, and it is this which shows the inferiority of the air-pumps worked off the main engines to those worked by their own independent motor.

Circulating Pumps.—I shall deal only with centrifugal pumps with independent motors, as these are generally used on board ship. They must fulfil two offices: first and principally to circulate water through the condensers, and, secondly and secondarily, but still the most important duty on board ship, to pump large quantities of water out of the ship in case of accident to the hull. In the first case, the duty is simply to circulate a large volume of water through the condenser at a very slight pressure, sufficient to overcome the resistance of the

tubes and inlet and outlet passages. In the second case, on the contrary, the pump must first of all overcome the head due to the difference of level inside and outside the ship, and then the resistance of the pipes; as the difference of level is always large, the quantity of water which the pump can put in motion is small. In order that the pump be suitable for this work, it is necessary first of all that it should have a high circumferential velocity of wheel or turbine, or, in other words, the velocity of rotation being limited for convenience, the turbine must be large in diameter. In the older engines the first condition only was provided for, with the result that the pumps were nearly useless for pumping from the bilges, although worked up to 500 or 600 revolutions; now, however, in modern engines the diameter of the pump is large enough to make them efficient bilge pumps at a moderate speed, not exceeding 300 revolutions per minute. A compromise is naturally a necessity, as the pumps cannot be perfectly adapted for both services, and we have to choose such proportions as will enable the pump to perform them effectively, if not efficiently. In order that suction from the bilges may be easy, the pump should be fitted as low down as possible, and, on the other hand, their motors should be situated high enough to keep them dry when the bilges are flooded. Both these conditions are well obtained when the pump is fitted with its axis vertical and the motor applied to the upper end of it. This arrangement, which I believe was fitted for the first time on board the "Inflexible," of the British Navy, has been repeated by us on the "Sardegna;" but from the fact that the motor must be horizontal, it is not so convenient on service as the method usually followed with the engine vertical and the axis of the pump horizontal. The suction of the pump is assisted considerably by fitting a screw at the lower end of the shaft at the mouth of the suction pipe, or by exciting an ascending current by means of a small ejector. When this is done the pump and its motor can be placed sufficiently high, preserving at the same time the most convenient arrangement of vertical engine and turbine. To insure the circulation of the water through the condensers, two pumps are fitted in the more recent ships, each of which is capable of performing the work alone; or, if the ship has two screws or two propelling engines on the same shaft, the circulating pipes are so arranged that either pump may be used for both condensers. Circulating pumps are constructed entirely of bronze or some similar metal, their shafts are cased with bronze, and run in bearings of hard wood. The circulating pipes between the sea suction valve, the pump, the condenser, and the main discharge valve are usually of copper, but it appears to me that in ships not copper sheathed it would be better to make these pipes of brass or delta metal, which have weak galvanic action with iron, and it would perhaps be better to make the inlet and outlet valves and the pump itself of delta metal also, so as to have a uniform material through the whole extent of the circulating system. The circulating pumps absorb very little power, so that in considering them more attention is given to securing regularity of action than economy of steam; the power absorbed in recent machinery varies

from 0·3 to 0·6 per cent. of the I.H.P. of the main engines. For this reason they have generally simple, not compound, engines, and, with a view to economy, they exhaust either into the L.P. receiver or into the feed-water heaters to heat up the boiler feed-water. In the American Navy, lift pumps connected with the air-pumps are used in several ships, and are exhaustively treated of by Mr. Dickie in his paper above mentioned; but he is of the opinion that centrifugal pumps are to be preferred.

Engine Framing.—The engine supports are constructed in a more rational manner than was formerly the case, as the bed plate is now dispensed with as an independent structure, and the framing forms a reinforcement or complement to that of the hull. The framing or box girders are, consequently, formed for the most part of plates and angle bars, similar to those used in the construction of the hull, and of which they form a part.

When this system of girders is properly studied and fully carried out, the supporting columns of the cylinders and the main bearing seatings are fixed directly on them, as has been done in our navy in the "Piemonte," "Sardegna," "Re Umberto," and "Sicilia," and in my opinion it would be difficult to find a better arrangement. There are, however, some engineers who think it desirable that the engine should have a true bed plate, generally of cast steel, on which it is mounted, independently of the underneath box girders; but I confess I cannot see the advantage unless it is for torpedo-boats and other small vessels with very slight hulls and exceptionally powerful engines. It is only just to say, however, that the independent base facilitates the fitting of the engines on board after they have been erected in the shop, especially when they are not of large size, and can be shipped all in one piece, which it is not possible to do if the engine is mounted directly on the box girders in the ship.

Joy's Hydraulic Reversing Eccentric.—Mr. Joy has proposed to apply to marine engines his hydraulic reversing eccentric which has already had satisfactory trials in locomotives. The apparatus is represented in figures 37, 38, and 39, which explain it clearly. It consists of two hydraulic cylinders inserted in the excentric sheave, and by means of which the position of the eccentric can be altered at will for "go ahead," "go astern," or "stop," just as with the ordinary double eccentric and link gearing. The liquid is forced into the hydraulic circuit in one direction or the other by a steam compressor, M, acting on a hydraulic press, N, from which it passes by means of the pipes, *pp*, through the hollow crankshaft into one of the small rams of the eccentric sheave of the first cylinder of the engine; for example, into the small ram giving the ahead position. The piston of this ram transmits the pressure to the opposite one of the same eccentric, from which it is transmitted through the hollow shaft to the eccentric of the second cylinder, and from this in the same way to that of the third, and finally by means of the pipes, *p'p'*, back again to the press, N. If the movement of the piston in the press, N, be reversed, the pressure in the circuit is reversed and the eccentrics will be placed in the position for going astern; and in whatever position the

motion of the piston may be arrested the corresponding position will be taken up by the eccentrics, so that all the movements for manœuvring the engines can be carried out with a single eccentric to each cylinder without the complication of links, levers, rods, &c.

Appropriate means are provided for correcting errors of adjustment which might result from leakage, and for varying the grade of expansion in one cylinder independently of the other. There is a hand-pump for moving the eccentrics when steam is not available. The liquid may be oil, in which case it serves to lubricate the eccentrics. If the apparatus gives satisfactory results in marine engines it offers many advantages which would favour its adoption.

Balancing Marine Engines.—As this question cannot yet be considered settled, we may omit the author's remarks on the period of vibration of the hull and its influence in diminishing or increasing by synchronism the disturbing effect of the engines, but he concludes by saying: "The positions of a node and loop of vibration in a merchant ship may be varied to a certain extent by shifting the position of her cargo, but little or nothing can be done in this direction on board a ship of war. Under these circumstances, and seeing that the data which can be obtained as to the position of a node and loop of vibration in the case of a ship to be built or in course of construction are most uncertain, and that the cause of vibration is the imperfect balance of the moving parts of the engines, it would appear to be most reasonable to go to the root of the matter and seek to insure immunity from vibration by perfecting the balance of these parts independently of the position of the nodes and loops and period of vibration of the hull, or of the velocity of rotation of the engines. Much can be done preventively in this way in arranging the relative position of the cylinders, air pumps, and slide valves, and in the relative movements of the pistons so as to give the least resultant and resulting moment of inertia. Thus in the case of an ordinary triple expansion three-cylinder engine, with cranks at 120°, the L.P. cylinder should be between the H.P. and I.P. cylinders; a better arrangement can be made with four cylinders (two L.P.), by placing the two large cylinders in the middle and arranging the cranks in proper succession, when the resultant and the couple due to the forces of inertia can be made very small. If this, however, is not sufficient, the remaining moment must be balanced by counterweights which will move in such a manner as to give a resultant and resulting moment equal and opposite.

"The study may be conveniently divided into two parts, the first comprising the organs having rotary movement, such as the crank-shaft, heads of connecting rods, &c., and the second comprising those having a rectilinear movement. The second part is a little more difficult, as in order to balance properly those parts having rectilinear motion it would be necessary to oppose to them masses having a similar movement, and which it is not easy to do in a simple manner. On the other hand the parts having a rotary motion are easily balanced by counterweights, but in both cases it is not the single parts which have to be balanced, but their resultant effect. In practice it

is not necessary that the balance should be perfect, but it is enough that it be sufficiently so to make the vibrations inappreciable, and as a matter of fact a perfect balance cannot be obtained, as there will always remain the local effects of inertia. Thus Mr. Yarrow, in his torpedo-boat destroyers, contents himself with balancing the moving parts by revolving weights at the two extremities of the crankshaft; this results in horizontal couples of inertia which tend to give the vessel horizontal movements, but these effects are hardly appreciable as the ship is very rigid in the horizontal direction and the inertia of the water externally tends to absorb or weaken them."

External Lubrication.—Again, omitting the author's interesting remarks on friction and its laws, and the theoretic action of lubricants, we take up his argument where he says: "It is true that the first point to have in view is perfect lubrication, in which condition the friction will be very little, even if the surfaces are very large. Naturally, when perfect lubrication is secured an augmentation in the dimensions of the rubbing surfaces is not justified. In the main bearings the necessary surface may be obtained either by increased diameter or increased length; the latter is more convenient as it does not necessitate increasing the diameter of the shaft, and the frictional moment of resistance decreases with this diameter. The pressure between the rubbing surfaces supported by the lubricant is not in general uniform, but varies from one point to the other of these surfaces. Mr. Tower found in his experiments that, in the case of a bearing applied to a horizontal shaft in motion and loaded on top, the pressure at the different points of a transverse section was a maximum at the upper part of the bearing and nothing at the sides. Similarly, in the longitudinal section of the bearing the pressure was a maximum at the centre and decreased rapidly to zero at the extremities.

"The pressure exerted on the rubbing surfaces being supported by the interposed lubricant, it is necessary to overcome the pressure at the point where the lubricant is introduced; the operation is, therefore, most easy where the pressure is least, and, in order that the lubricant should penetrate to the parts where the pressure is greater, it should be introduced where the motion of the surfaces would tend to carry it to these parts. It is said that with use the lubricant loses its lubricating qualities, so that it is necessary to renew it.

"This deterioration is notably increased by the dust floating in the atmosphere, especially on board ship, where coal-dust contributes principally to this deterioration. An abundant circulation of the lubricant lessens these ill effects, as it is constantly and rapidly renewed, and when associated with filtration the defect is entirely overcome. The rapid renewal of the lubricant is only possible when it is liquid, and for this reason, independently of its other good qualities, a liquid lubricant is more suitable than semi-liquid or fatty oil for good lubrication; in fact, a perfect lubrication is only possible with liquid oils.

"When liquid and abundant, the thickness of the stratum of oil interposed between the surfaces may be such that the influence of the nature of the surfaces and quality of the oil is almost *nil*. Thus, in

the case of a vertical shaft supported on a hydraulic step bearing, there is very little difference in the friction whether the liquid forced into the step be oil or water, or whether the surfaces of the bearing and foot of the shaft be smooth or slightly rough. It is not so, however, if the lubrication is not perfect and abundant; if the lubrication is perfect but not superabundant, the influence of the nature of the lubricant makes itself felt, different liquids having different degrees of cohesion and power to support pressure. The lubricants, however, which have the greatest cohesion, other conditions being equal, support the greatest pressure, and consequently require the least surface area, or with equal surface will most easily maintain perfect lubrication. Fluidity and adhesion to the surfaces are also necessary qualities of good lubricants, and ordinarily the most adhesive oils are also the most fluid. The soft antifriction metals, mixtures of tin, copper, and antimony, have the double property of giving very smooth surface and good adhesion, especially with vegetable oils, thus forcing the lubricant to insinuate and maintain itself between the surfaces. When the lubrication is not superabundant the temperature has an influence on it also, as Mr. Tower found in some experiments that the friction was diminished by about one-third by an increase of temperature from 16° to 50° C."

Method of Lubrication.—We have seen that to obtain perfect lubrication an abundant circulation between the rubbing surfaces is necessary. In some cases forced circulation at great pressure is necessary, as for the step bearings of the vertical shafts of turbines, disintegrators, &c., but in the majority of cases natural circulation is sufficient. In order that the lubrication may be abundant and, at the same time, economical, the oil on leaving the bearings must be collected and employed over again, when it becomes necessary to purify it before it is reconducted into the bearings. This purification may be effected by intermittent or continuous filtration. The circulation may be complete or incomplete: in the first case the oil after filtration is returned continuously and automatically between the bearing surfaces, and in the second is returned by hand at intervals. In the ordinary bath system of lubrication, the oil from the bearings returning into the bath tends to impregnate it with impurities. In this case the circulation is complete, but there is no filtration at all, or it is intermittent, that is, the oil in the bath must be renewed occasionally and filtered before re-using it. The purification, however, may be made continuous by passing the oil from the bearings through a filtering compartment before it reaches the bath. Fig. 40 shows this arrangement for worm-wheel gearing, for which the bath system of lubrication is often applied.

In the following figures are shown some arrangements which have been applied by Mr. Verney, on the principle of "abundant lubrication, with recovery and filtration," to the various cases which are met with in practice, more especially for external lubrication. Fig. 41 shows an ordinary shaft bearing and lubricator, with incomplete circulation and intermittent filtration; Fig. 42 shows the same bearing with wick-lubrication, continuous filtration, and complete circulation.

In both the lubricant is applied at the upper central part of the bearing and guided to the extremities by small channels, where it is collected in an annular space around the bearing and conducted to the reservoir underneath. This operation is facilitated by a wire or thin metal ring, which rides on the shaft in the annular space. In Fig. 42 the reservoir also contains the filter through which the oil must pass continuously, and the filtered oil is conducted again to the top of the bearing by means of the wick, so that the circulation is complete. Between the wick and the shaft there is interposed a sheet of velvet, which transmits the oil to the shaft, and at the same time prevents it from dragging the wick along with it in its movement of rotation. For small parts of the machinery complete circulation is generally impracticable, and we must be content with incomplete, but the filtration may be effected in the lubricator itself. Figs. 41 and 43 show this arrangement applied to shafting and cross-head bearings. With the "abundant lubrication with recovery" system, proposed especially by Mr. Verney, we not only obtain perfect lubrication when it is properly carried out, but also great economy, as the oil is not consumed by the rubbing surfaces, which remain always completely separated, and it preserves for a long time its lubricating qualities, so that it can be, and is, recovered and used over again.

Mr. Verney advises filtration by means of scrap or granulated lead. According to Mr. Verney, the granulated lead, or lead shavings, when used as filters, not only serve for this purpose but also eliminate all impurities which the oil may originally contain, and insure regularity of lubrication by preventing the obstruction of the wick, if this is used.

Naturally in time the lead filters will become clogged, but this will take place very slowly and can be still further delayed by making the filtering surface very large. Even in small lubricators the filtering surface is very large in proportion to the area of the oil passage, about 1,000 times, and experience has shown that with this proportion under ordinary conditions the filter will act efficiently for years. The lead filters are easily cleaned by scalding with soda or potash, by washing with mineral lamp oil, or by heating the lead particles to red heat when granulated lead is used. Fig. 44 shows an ordinary lubricator with lead filter and regulator for oil supply, Figs. 41 and 43 the same with the addition of the sight feed B.

Choice of a Lubricant.—The properties which a good lubricant should possess are:—

1st. Unctuosity, this is aptitude for reducing friction.
2nd. Capacity for preserving this property when in use between rubbing surfaces.
3rd. Fluidity, or aptitude for penetration between the rubbing surfaces.
4th. Adhesiveness, or adhesion to the surfaces to be lubricated.
5th. Cohesion, capacity for sustaining great pressure without being forced out.
6th. Absence of acids or other substances which could injure

the bearing surfaces, and a composition which remains unaltered when exposed to air, or by its employment as a lubricant.

7th. Absence of any tendency to agglutination or clogging on the surfaces.

In the writings of Messrs. Thurston, Tower, Everest, and Verney, above quoted, the reader will find all necessary information on the qualities of various lubricants and the methods of ascertaining them. We give here Mr. Tower's table of the unctuosity of the lubricants most in use.

Table showing the frictional resistance of some lubricants tried under the following conditions: Bath lubrication, temperature 32° C., speed of shaft 300 revolutions per minute, load on the bearing from 7 to 21 kilos. per sq. cm. :—

Sperm oil.....	0·219	kilos. total resistance.
Mineral oil	0·282	,, ,,
Olive oil	0·297	,, ,,
Mineral grease.....	0·475	,, ,,

The above table will show also the cohesion, which will be inversely proportionate to the resistances here given. In our navy, olive oil is preferred for external lubrication; comparative experiments carried out on board several ships under service conditions having proved in favour of it, and on the other hand there is an abundant supply of it in our country, which tends to favour its employment, although the price is somewhat high. We have also experiments in progress in order to ascertain to what extent grease can be introduced for the lubrication of the external parts of the engines on board ship.

A good system of distribution contributes greatly to economy in the ordinary system of lubrication, by means of which the supply of oil to the various parts of the mechanism can be regulated from one or very few points. A simple and practical system for some time in use is that of distributing boxes of oil placed high up and furnished with small cocks and oil-pipes leading to the several parts of the machinery, so that the supply, regulated by each cock, is visible. In our navy, lubricating boxes reversible on the Foley system, Fig. 45, are in use, by means of which the lubrication of the whole of the parts can be interrupted at once simply by reversing the box, without touching the regulating cocks, which will remain adjusted and ready for use when the box is again reversed on starting the engines. A levelling tube with air bubble shows the quantity of oil in the box and how the lubrication is proceeding. The apparatus acts as a siphon, and with each bubble of air that enters a drop of oil is supplied to the machinery.

Quality of the Rubbing Surfaces.—It is well known that the so-called white metal is extensively used in marine machinery for one of the rubbing surfaces of the moving parts. It is applied not only to the crankshaft and crankhead bearings, but also frequently to the

piston-rod guides and crosshead bearings (which formerly were made entirely of bronze) and even to the metallic rings of the pistons. The importance and usefulness of the white metal increases when the lubrication is deficient, but if the lubrication is abundant the action of the metal is, in my opinion, inappreciable.

Internal Lubrication.—On this head there is very little to say. The humidity of the steam in the cylinders is in itself a good lubricant, and as the use of fatty substances in the cylinders tends to cause injury to the boilers by being carried over with the feed water, internal lubrication is avoided as much as possible. Many are of the opinion that the oil which penetrates into the cylinders with the piston rods from the glands is sufficient; but it is well to have the means of lubricating the cylinders, &c., internally when required. The well known "automatic sight-feed lubricators" fitted to the main steam pipes serve this purpose very well. Mineral oil with a boiling point of about 300° C., so that it may remain liquid in the heated space in which it has to act, should be used for internal lubrication.

Mudd's Screwshaft Casing.—Mr. Mudd, of Hartlepool, has introduced a casing of indiarubber, or some other elastic substance, for the protection of screwshafts, formed so that it will fit tightly and be perfectly secured along the whole length AA between the bronze casings for the shaft bearings (Fig. 46), which are fitted to receive the ends of the elastic casing so as to make a good connection. Before fitting it on, the shaft is polished and smeared with a special cement to which the casing adheres perfectly. As is well known, the shafts are usually cased with bronze in order to protect them from galvanic action, but it has the defect that it does not give perfect protection, and sometimes causes the injury which it is supposed to prevent. For this reason, in my opinion, the elastic casing is a very important improvement if experience shows it to be successful.

See's Ejector for Ashes.—This was described in the Naval Notes for the R.U.S.I. Journal some time ago. It is shown in Figs. 47, 48, and consists of a hopper, T, and a water jet ejector, E, fed by a pump giving a pressure to the jet of 140 to 180 lbs. per sq. inch; a tube, S, leads from the bottom of the hopper overboard 5 or 6 ft. above the water line. The apparatus is fitted with a cover which can be secured by nuts and screws when not in use, and with the drain cock, *r*; a cock, R, serves to regulate the jet. The advantages which the ejector has over the ordinary elevators are:—

1st. Simplicity, as it can be placed anywhere and takes up little space.
2nd. Requires very little labour from the stokers.
3rd. Does not require large openings through the protective decks or ship's side.
4th. Makes no noise.
5th. The ashes can be discharged when under forced draught with closed stokeholds, and whatever may be the state of the sea.
6th. The upper decks and bridges are not made dirty by the cinders and ashes being blown about them.

Auxiliary Mechanism with Hydraulic Motors.—In my article published in this "Rivista," on the "Transmission and Distribution of Power in Modern Ships," I noticed, amongst other things, the so-called hydraulic system in use for manœuvring heavy guns, and showed that, whilst it was very suitable for slow movements such as steering gear, capstan gear, &c., it was not adapted for working high speed mechanism such as ventilators, dynamo machinery, &c., for which steam or compressed air was more suitable. I did not, however, take account of the fact that the hydraulic power, which in the above-named mechanism is used under a statical form, might be well adapted also for high speed motors if employed in the kinetic form. In addition to large turbines which are employed in industrial establishments for transmitting motion by shafting to every sort of machinery, we have examples in Italy of hydraulic installations in which the power of water under pressure is used directly for working all the machinery, from the slowest to the fastest, by means of small turbines applied to each machine; it is well known that in Switzerland this system has been brought to a high grade of perfection. But in all these cases the water pressure being relatively small, the hydraulic motors and pipes must be proportionately large, so that the system did not appear to me to be well adapted for use on board ship. I was not aware that the system had received elsewhere a recent development adapting it to the high pressures used on board ships; but I have been enlightened on the subject by Mr. G. W. Dickie, who proposes the adoption of hydraulic pressure for all the auxiliary machinery not in connection with the propelling machinery, by employing its energy in the statical form for the slow-moving mechanism, and in the kinetic form by means of jet water wheels for high speed motors.

These wheels, which are capable of very high speed and give an efficiency of 80 per cent., are both simple and small in dimensions. With the high-water pressures the pipes and motors become small, and lend themselves admirably to the transmission of power on board ship, and permit the realization of all the advantages of facility of installation, simplicity, security, and regularity of action, with facility of maintenance and repair. In Fig. 49 is shown one of the so-called jet motors applied to a ventilator as proposed by Mr. Dickie, and in truth nothing can be more simple. Dynamo-electric machinery can be driven directly in the same way instead of by delicate steam motors such as are now employed. It is perhaps superfluous to observe that by the hydraulic system the grave disadvantages of heating the different parts of the ship in which it acts, and of complete paralysis in case of flooding the pipes, &c., are avoided, besides which it may be well to add that there would be sensible saving of weight in the system proposed by Mr. Dickie. The idea, therefore, appears to be a good one and well worth a trial.

Accumulators for Boiler Feed.—Mr. Yarrow, with a view of insuring regularity and constancy in the feed supply in his new 27-knot destroyers of the "Hornet" type with tubulous boilers, has fitted an accumulator into which the feed water is pumped and kept at a

pressure of about 50 lbs. per square inch, from which it is then supplied to the boilers by the feed pumps. In this way not only is the suction of the feed pumps assured, but the attendant is able to see by the level of the water in the accumulator how the boiler feed is going on, and increase or diminish the supply as necessary. In my opinion, Mr. Yarrow's system has the defect of increasing the number of pumps necessary for the feed supply, whilst it would be a great advantage, if possible, to diminish them. It appears to me that this could be done by arranging the accumulator so that the pressure maintained in it should be above the boiler pressure, sufficiently to overcome the resistance of the pipes, valves, &c., to the passage of the water from the accumulator to the boilers. By doing this, the second series of feed pumps could be dispensed with, and a considerable saving of weight and space effected, with simplicity of fitting and working, since the feed could be regulated in the stokeholds by simply adjusting the feed valves.

Fig. 50 shows an accumulator which, it appears to me, would satisfy all the conditions of this service. It consists of a vertical cylinder, A, with a heavy piston, B, steam being admitted above the piston at the boiler pressure from the main steam pipe, and the feed water being pumped into the space beneath it. The piston rod passes through the lower end of the cylinder, and carries a platform, which can be weighted to give the required excess of pressure to the feed water in order to overcome the friction of the feed pipes, &c. A valve, V, fitted to the lower part of the cylinder, serves to open and close the communication between the accumulator and feed pipe, and a small cock at the lower end of the piston rod, for draining away any water which may accumulate above the piston. A more elegant solution would be to make the piston fixed and the cylinder movable, so as to use the great weight of the latter to give the required excess of pressure; other solutions can be easily imagined.

Here I must conclude, at least as regards the first part of this study, that is, the progress made in the construction of marine machinery.[1] Other progress of the same nature has been made during the long period of this publication, interrupted by circumstances not under my control; but as these refer principally to the boilers and other parts of the motive apparatus of which I have already treated, I will not speak of them now so as not to begin all over again.

Before finishing, however, the author thanks the translator who has enabled the R.U.S.I. to reproduce his paper in the journal of that institution, "notwithstanding that there can be nothing in it which is not well known to him and to all those who occupy themselves with naval engineering."[2]

[1] We hope shortly to publish an appendix to these articles on the subject of tubulous or water tube boilers, also by Colonel Nabor Soliani, as we think the whole will form a useful summary of modern engineering practice.—ED. R.U.S.I.

[2] I believe there are very few officers in the British Navy, whether executive or engineer, who read these articles of Colonel Nabor Soliani but will profit considerably by the perusal and feel very much indebted to him for having collected so much useful information and presented it in such an interesting form.—T. J. H.

Figs. 37, 38 & 39. JOY'S HYDRAULIC REVERSI

Fig. 37.

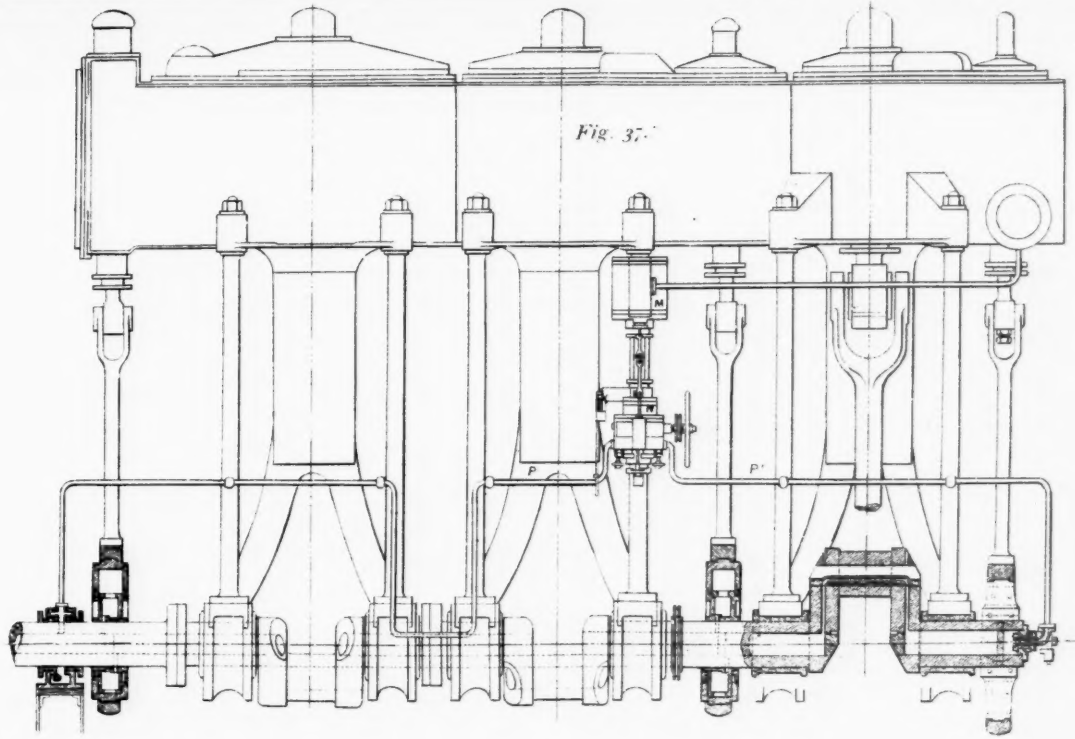
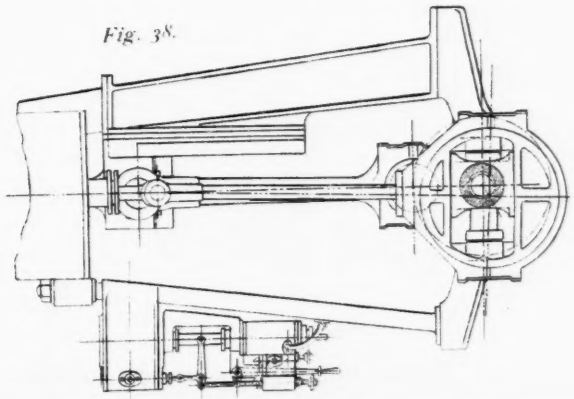
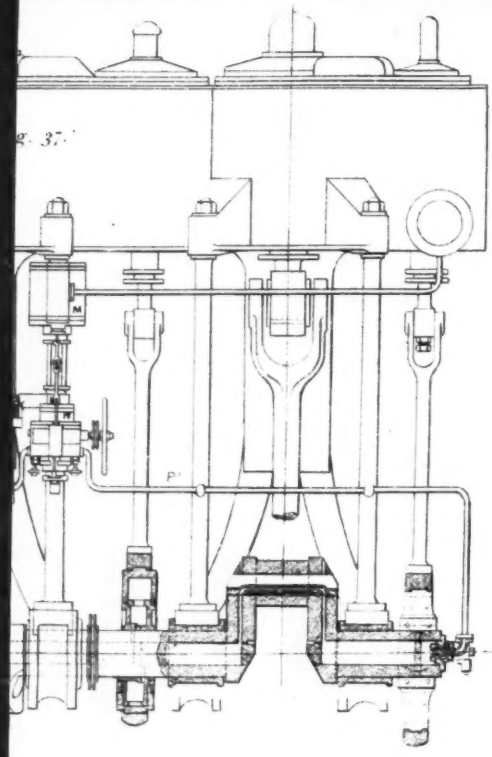


Fig. 38.



Figs. 37, 38 & 39. JOY'S HYDRAULIC REVERSING AND STOPPING EXCENTRIC.



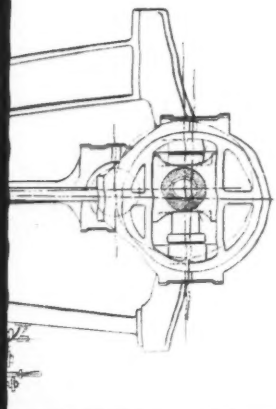


Fig. 39.

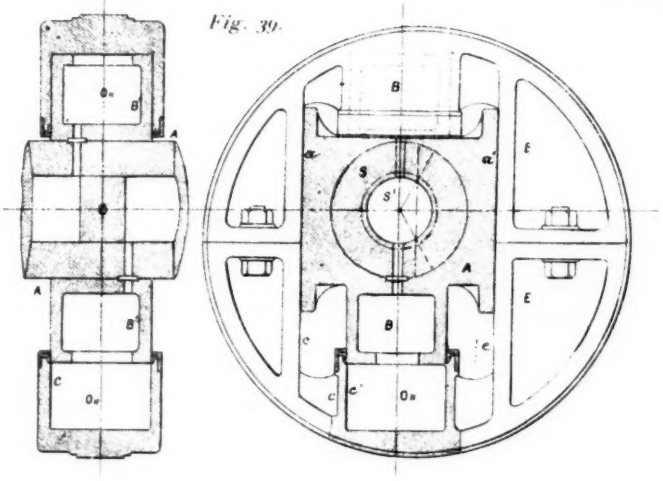


Fig. 40. BATH LUBRICATOR, WITH COMPLETE CIRCULATION AND CONTINUOUS FILTRATION.

Fig. 40.

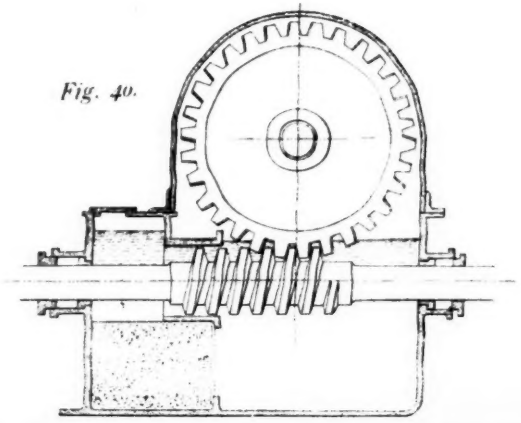


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Fig. 41. SHAFT BEARING WITH "ABUNDANT LUBRICATION AND RECOVERY," CIRCULATION INCOMPLETE, FILTRATION INTERMITTENT.

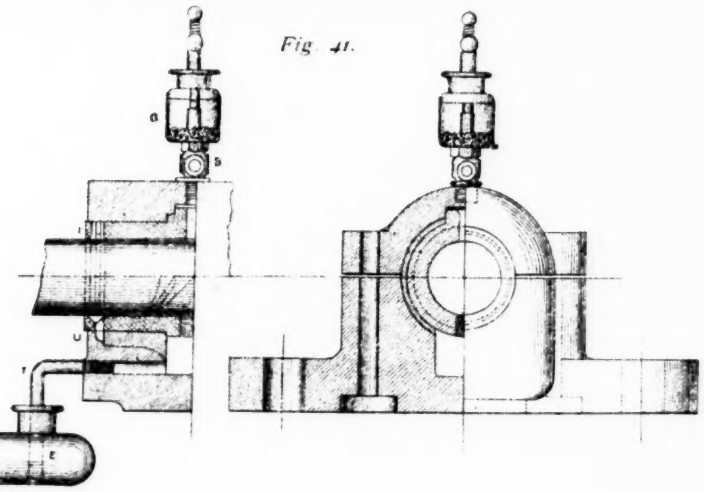

Fig. 43. "ABUNDANT LUBRICATION AND RECOVERY," CIRCULATION INCOMPLETE, FILTRATION INTERMITTENT

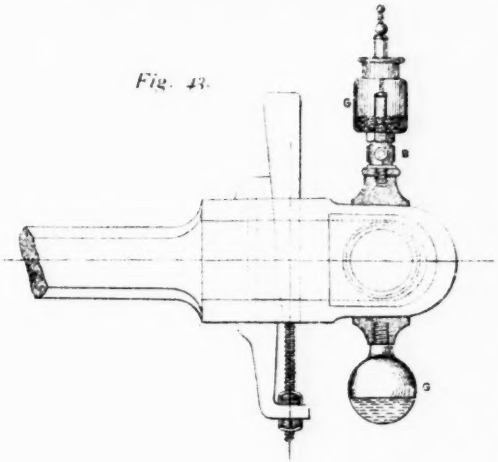

Fig. 42. BEARING WITH "ABUNDANT LUBRICATION AND RECOVERY," CIRCULATION INCOMPLETE, FILTRATION INTERMITTENT

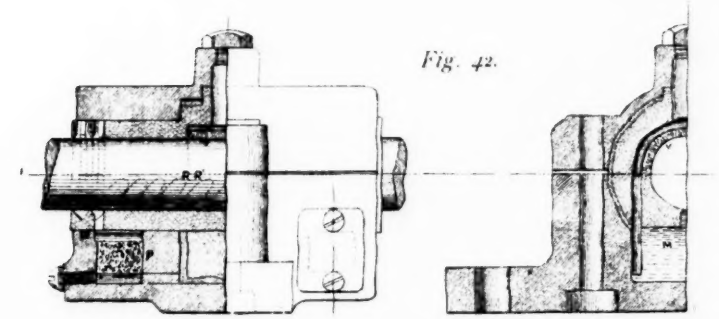

Fig. 44. ORDINARY LUBRICATOR WITH FILTER.

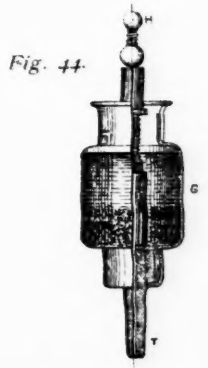

Fig. 45. REVERSING

Fig. 45.

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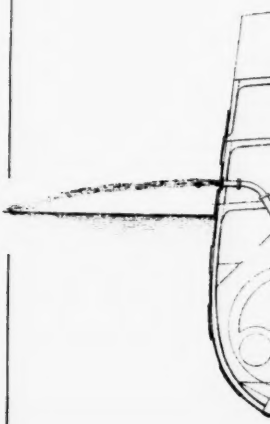


SING DISTRIBUTING BOX LUBRICATOR, FOLEY'S SYSTEM.

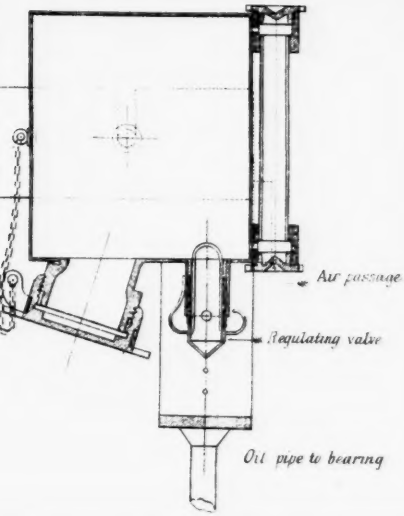
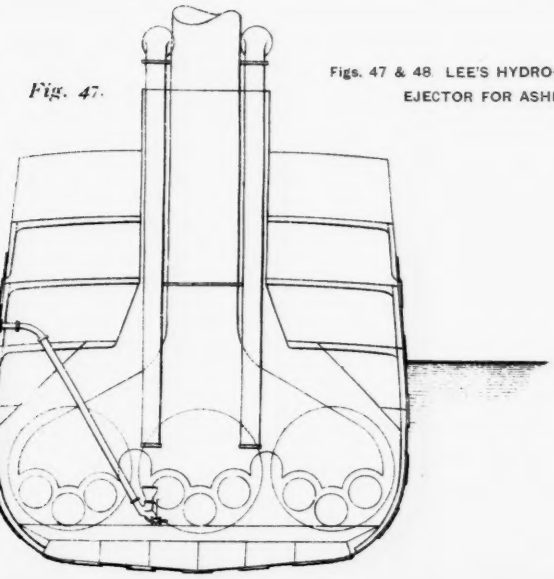


Fig. 46. MUDD'S CASING FOR PROPELLER

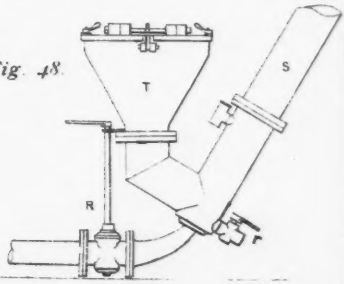
Fig. 46.

Fig. 47.



Figs. 47 & 48. LEE'S HYDRO-DYNAMIC EJECTOR FOR ASHES.

Fig. 48.



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LEE'S HYDRO-DYNAMIC
CTOR FOR ASHES.

Fig. 46. MUDD'S CASING FOR PROPELLER SHAFTING.

Fig. 46.

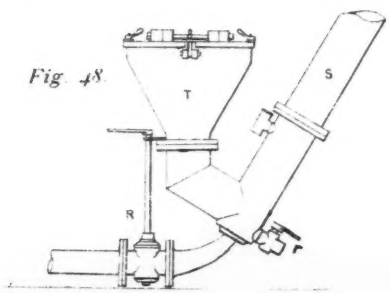

Fig. 48

Fig. 49. DICKIE'S HYDRAULIC MOTOR FOR AUX

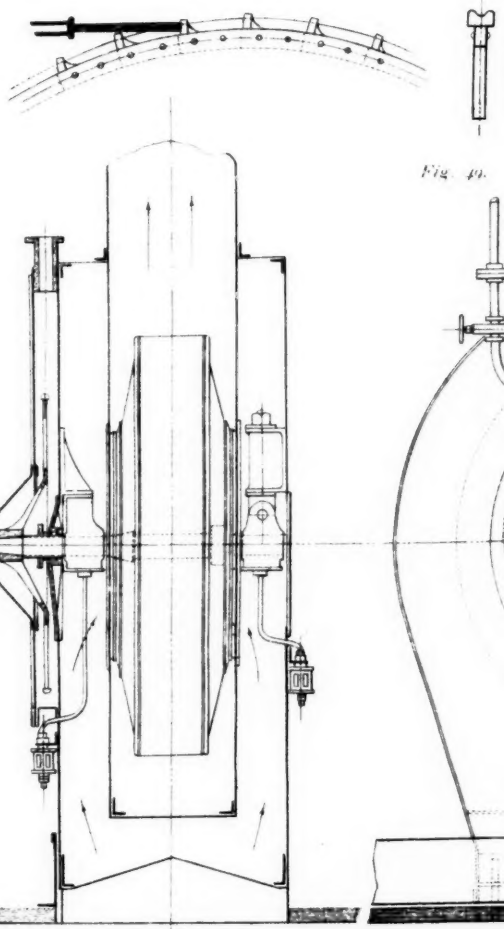

Fig. 49.

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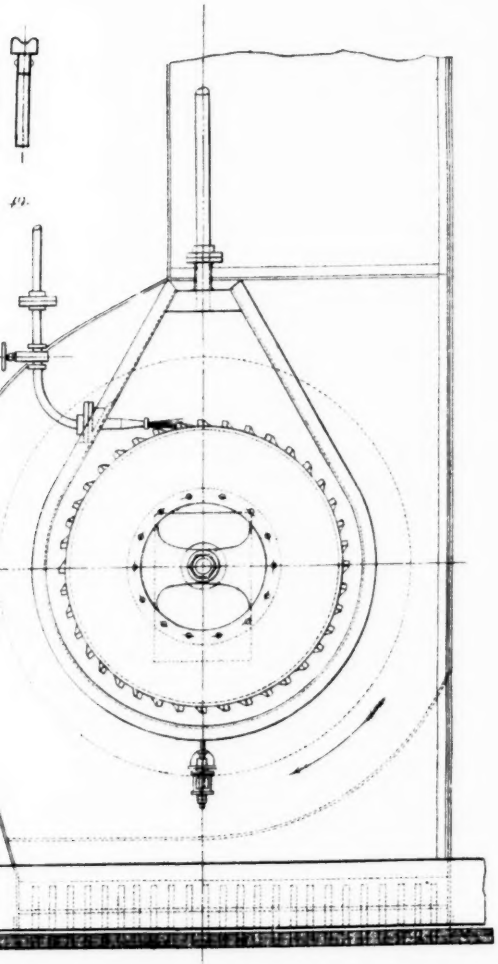
OR AUXILIARY MECHANISM ON BOARD SHIP.



49.

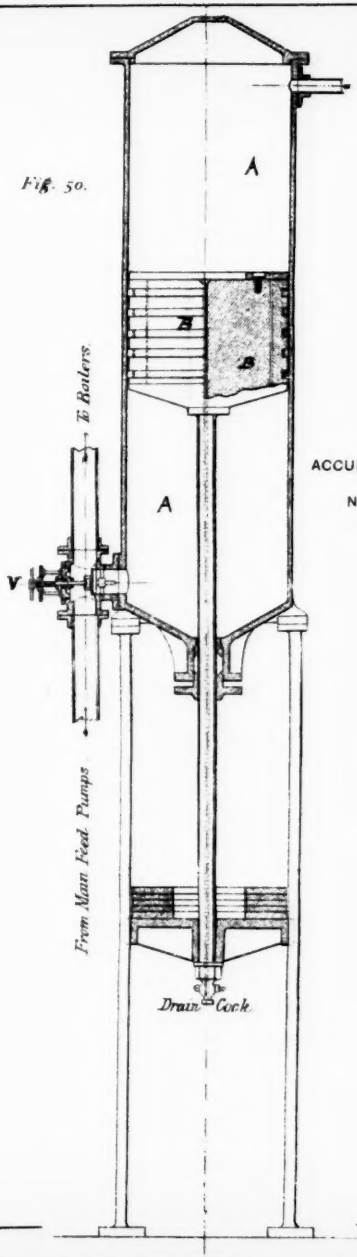


Fig. 50.

Fig. 50.

ACCUMULATOR FOR FEED,

NABOR SOLIANI.

v. LÖBELL'S ANNUAL REPORTS ON THE CHANGES AND PROGRESS IN MILITARY MATTERS DURING 1893.[1]

Compiled by Colonel H. T. HILDYARD, Commandant, Staff College.

It is to be much regretted that a further change has become necessary in the management of this valuable military publication, owing to the decease, in April last, of Lieutenant-General von Jarotzky. As was pointed out last year, with reference to the nineteenth annual issue, the first edited by this distinguished and much lamented officer, his endeavour was to continue the publication on the general lines laid down by his predecessor, while introducing such developments as might appear desirable. The volume now issued sufficiently proves that this endeavour was not made in vain, and apart from the intrinsic merit of its contents—which is great—a sad interest must always be attached to it from the fact that its preface was written by the late Lieutenant-General von Jarotzky, and is dated April, 1894, shortly before his death.

In this preface reference is made to the tables introduced for the first time in the nineteenth issue, 1892, showing in the case of each State dealt with in Part I, in a condensed tabular form, the composition and strength of its armed forces.

This addition was generally recognised as of great practical convenience, and the arrangement has been continued in the present volume with great advantage.

As is usually the case, the space occupied in Part I by details respecting the armies of the several European States is in general accord with the importance attributed by Germany to these forces. Thus France, Germany, Russia, and Austria have the lion's share, Italy and England following in second line. Bulgaria and the United States of America appear as additions, not comprised in the preceding issue.

In Part II the usual subjects, comprising the several branches of military art and science, are dealt with, except that military railways and telegraphs are this year omitted.

Under Part III will be found the record of military operations that have taken place, which were confined to minor conflicts in Africa, and comprised enterprises against the Arabs in the Congo State, the second expedition of the French to Dahomey, and the conflict between the Italians and dervishes at Agordat.

The following summary is necessarily much curtailed, and it is

[1] v. Löbell's "Jahresberichte über die Veränderungen und Fortschritte im Militärwesen." 20th annual issue: 1893. By the late Lieutenant-General Th. v. Jarotzky. Berlin: Mittler, 1894. 1 vol. Pp. 515. Price 12 marks.

confined to the two first parts of the Reports. It claims only to reproduce, in a condensed form, for the benefit of those officers who are unable to read the German original, some of the more interesting portions of the work. Happily the number of these officers is constantly diminishing, and it cannot be too strongly impressed upon all officers who have a sufficient knowledge of German that they should read the original. By doing so they will gain not only a more thorough insight into the organization of foreign armies and the leading military questions of the day, but they will increase their vocabulary by the majority of the modern military terms employed in Germany.

GERMANY.

Peace Strength of Active Army.

Arm.	Officers.	Non-commissioned officers, musicians, rank and file.	Service horses.	Horsed guns.	Horsed ammunition wagons.
Infantry	12,028	363,774	—	—	—
Cavalry	2,326	63,695	63,157	—	—
Field artillery[1]	2,623	56,469	28,538	2,542	97
Foot artillery	858	22,271	16	—	—
Pioneers	559	14,567	—	—	—
Train	305	7,391	4,083	—	—
	18,699	528,167	95,794	2,542	97

Organization.—The organic army law, as finally passed by the Reichstag, dated the 3rd August, 1893, differed materially from the Bill as first introduced in the previous year. The particulars given on page 3 of the précis of v. Löbell's Reports for 1892 referred to that Bill; but as amended and finally passed the following are some of the principal provisions of the law:—

Article I.—1st. The peace strength of the German army in privates, lance-corporals, and corporals is fixed at 479,229 men for the period from the 1st October, 1893, to the 31st March, 1899, as the average annual strength.

The one-year Volunteers are not included in the peace effective strength.

The non-commissioned officers are provided for in the same manner as the officers, surgeons, and civil officials in the Imperial Estimates.

2nd. From the 1st October, 1893, the organization by arms is:—

[1] This includes Horse artillery.

Infantry, 538 battalions and 173 half battalions.
Cavalry, 465 squadrons.
Field artillery, 494 batteries.
Foot artillery, 37 battalions.
Pioneers, 23 battalions.
Railway troops, 7 battalions.
Train, 21 battalions.

Article II.—For the period from the 1st October, 1893, to the 31st March, 1899, the following provisions will be in force regarding the period of obligation to serve:—

1st. During the period of obligation to serve in the active army the men of the cavalry and of the mounted field artillery are bound to serve with the colours without interruption during the first three years; all other men the first two years.

In the event of reinforcements becoming necessary, the men dismissed under the first paragraph may be recalled to active service on the order of the Emperor.

Ministry of War.—The arms department as such has been done away with. The general War Department absorbs the branches of the previously existing arms department in the following manner:—

1st. The small-arms branch and the branch for dismounted troops are amalgamated in one, to be called the "Infantry Branch."

2nd. The artillery branch, which is to be styled the "Foot Artillery Branch," is, so far as practicable, to be restricted to matter relating to foot artillery.

The central division is to be expanded as an experiment into one department with two branches.

Infantry.—As a result of pretty considerable changes in the division of the Landwehr districts in the spheres of the 6th, 7th, 8th, 9th, 12th, and 14th Army Corps, a great number of infantry brigades have quite a different distribution of their recruiting districts, which has further been influenced by the circumstance that cavalry and field artillery brigades have also been entrusted experimentally with the performance of recruiting duties.

Field Artillery.—A change has been imported into the post of Inspector of Field Artillery, by which he may report directly to His Majesty the Emperor; in connection with this, various alterations follow in regard to the relation of field artillery brigades to the Inspector of Field Artillery and to the general commanding the army corps respectively.

Foot Artillery.—An important change has taken place in organization. The number of foot artillery inspections has been increased from four to six, regard being had to the want of generals of this arm in war and also with a view to employing them in times of peace in conditions more like those of war. A change has been made simultaneously in the stations of the arm, which are now as indicated in the following table, in which is also shown the allotment to the several foot artillery inspections of the troops of that arm and of the artillery depôt inspections.

Distribution of the Foot Artillery Inspections in Peace.

Foot artillery inspections.	Station.	Foot artillery formations.	Artillery depôt inspections.	With the artillery depôts in	
				Fortresses.	Open places.
I.	Berlin	Guard Foot Artillery Regiment. Foot Artillery Regiment Encke (Magdeburg) No. 4. Lower Silesia Foot Artillery Regiment No. 5.	1 and 3	Spandau. Küstrin. Posen. Magdeburg.	Berlin. Erfurt. Wittenberg.
II.	Berlin	Foot Artillery Regiment v. Linger (East Prussia) No. I. Foot Artillery Regiment v. Hindersin (Pomerania) No. 2.	2	Königsberg (Memel). Boyen. Pillau. Swinemünde. Dantzig.	Stettin. Bromberg. Rendsburg. Schwerin.
III.	Cologne.....	Westphalia Foot Artillery Regiment No. 7. Schleswig-Holstein Foot Artillery Regiment No. 9.	3	Wesel. Cologne. Coblenz.	Münster. Hanover. Cassel. Darmstadt.
IV.	Metz	Foot Artillery Regiment General Feldzeugmeister, Brandenburg, No. 3. Rhenish Foot Artillery Regiment No. 8. Royal Saxon Foot Artillery Regiment No. 12.	4	Mainz. Metz. Diedenhofen.	Saarlouis.
V.	Thorn	Foot Artillery Regiment v. Dieskau (Silesian) No. 6. Foot Artillery Regiment No. 11. Foot Artillery Regiment No. 15.	1	Glogau. Glatz. Thorn. Graudenz.	Breslau. Neisse.
VI.	Strasburg, E.	Foot Artillery Regiment No. 10. Foot Battalion No. 13. Baden Foot Artillery Regiment No. 14.	4	Strasburg (Bitsch). Ulm. Neu Breisach.	Karlsruhe. Rastatt.

Engineer Corps.—Important changes in organization have been made here also. One of the previously existing four Engineer inspections, the 4th, has been abolished. The previous 8th, 9th, and 10th fortress inspections have been converted into the 2nd, 4th, and 5th, located at Kiel, Thorn, and Strasburg respectively. The two fortress inspections formerly at Berlin and Mainz have been dispensed with.

The following shows the distribution for the future of the Engineer inspections :—

1st Engineer Inspection, Berlin				1st Fortress Inspection,		Königsberg.
				2nd	„	Kiel.
2nd	„	„	„	3rd	„	Posen.
				4th	„	Thorn.
3rd	„	„	Strasburg	5th	„	Strasburg.
				6th	„	Metz.
				7th	„	Cologne.

There has also been a change in the pioneer inspections, which have been increased by one provisionally; besides this, a new superior command has been created for the pioneer troops. It is restricted for the present to the 1st, 15th, and 16th Army Corps, and the officer holding it is styled commander of the pioneers of the army corps concerned. The requirements of war rendered this appointment indispensable.

The following is the distribution of the several inspections :—

1st Pioneer Inspection, Berlin				Command of the pioneers, 1st Army Corps, Königsberg.
2nd	„	„	Mainz	Command of the pioneers, 15th Army Corps, Strasburg.
				Command of the pioneers, 16th Army Corps, Metz.
3rd	„	„	provisional, Magdeburg.	

To the 1st and 2nd inspections are allotted seven pioneer battalions each and six to the 3rd.

New Formations. Infantry.—From 2nd October, 1893, a half battalion was added to each of the existing 133 infantry regiments of the Prussian Army and of the contingents administered by Prussia, and constituted the 4th battalion; the companies bear the numbers 13 and 14 respectively. Similar provisions took effect in the 20 Bavarian infantry regiments, in the 8 Wurtemberg, and in the 12 of Saxony.

Field Artillery.—16 division staffs for field batteries and 48 batteries; 1 division staff and 3 batteries as 2nd Instructional Division of the field artillery practice school. The field batteries were renumbered throughout the regiments; new 4th Divisions were given to 14 of them, and new 3rd Divisions to two; in four, existing 4th Divisions were completed by the addition of one new battery.

In Bavaria 2 division staffs and 6 field batteries (3 to each army corps).

In Wurtemberg 1 division staff and 3 field batteries.

In Saxony the field artillery is now constituted in 2 regiments of 4 divisions of 3 batteries and 1 regiment of 3 divisions of 3 batteries as follows :—

Field artillery regiment	No. 12,	9 dismounted and 3 mounted batteries.
„ „	No. 28,	9 dismounted batteries.
„ „	No. 32, 12	„ „

Foot Artillery.—In Prussia three new foot artillery regimental staffs were created, viz. :—

For the Schleswig-Holstein Foot Artillery Regiment No. 9.
„ Baden „ „ No. 14.
„ Foot Artillery Regiment No. 15.

Five new battalions were added to the arm, viz. :—

A 2nd battalion for the Schleswig-Holstein Foot Artillery Regiment No. 9.
A 2nd battalion for the Baden Foot Artillery Regiment No. 14.
A 1st and 2nd battalion for the Baden Foot Artillery No. 15.
A 3rd battalion for the Foot Artillery Regiment v. Hindersin (Pomeranian) No. 2.

A third instructional company was added also to the school of gunnery, together with a battalion commander and an adjutant.

In Bavaria a third battalion was added to the 2nd Foot Artillery Regiment.

In Wurtemberg the 13th Foot Artillery Battalion has been converted into a Prussian one.

In Saxony a fifth company (9th) has been added to the 2nd Battalion of the Foot Artillery Regiment No. 12.

Train.—A third company has been added to the Prussian Train Battalion No. 16.

Recruiting Arrangements.—Under the new law the annual contingents allotted to the several units are to be as stated below, both for previously existing units and for those added to the establishment by the above-mentioned law :—

Battalions of infantry, including the 4th battalions.
The Grand Duke of Mecklenburg's jäger battalion No. 14.
Dismounted field artillery batteries.
Battalions of foot artillery.
Pioneer battalions.
Railway battalions.
Balloon division.

Train battalions having two years' service with the colours.

Half of the established number of corporals, lance-corporals, privates, and hospital subordinates, exclusive of re-engaged men; half the vacancies in the authorized number of these may be filled by calling up more recruits :—

Other jäger battalions on the higher establishment, at least	283	recruits each.
The guards jäger battalion, at least	250	„
Other jäger battalions on the lower establishment, at least	258	„
Cavalry requirements on the higher establishment, at least	35	„
Cavalry requirements on the medium establishment, at least	32	„
Cavalry requirements on the lower establishment, at least	25	„

Train companies, men having a half year's service with the colours in the autumn of 1893 and the spring of 1894, 38 each.

The whole of the troops are to replace yearly half of the tradesmen borne on the future establishment.

In addition to the recruits to be called up under the foregoing provisions, the Minister of War is authorized to call up a sufficient number to replace vacancies arising from death and unfitness, also for replacing the sick attendants, bakers, &c., who have served their time.

Increase in the Number of Officers.—The number of officers who joined the active list of the army was, infantry, 757; cavalry, 215; field artillery, 277; foot artillery, 58; pioneers and railway troops, 70; total, 1,377 officers.

The reserve and landwehr received together 1,515 second lieutenants of all arms.

The waste to put against these numbers was as follows:—From the active list, 67 generals, 55 colonels, 42 lieutenant-colonels, 113 majors, 162 captains, 99 first lieutenants, and 229 second lieutenants of all arms: total, 767 officers; from the reserve and landwehr, 79 field officers, 190 captains, 958 first and second lieutenants of all arms; total 1,227 officers.

The above numbers represent an increment of 610 officers to the active list and 288 to the reserve and landwehr.

Non-commissioned Officers.—Effect was given in 1893 to the scheme long advocated in the army of giving a gratuity to those soldiers who engage to serve with the colours after the termination of their obligation. It is hoped by this means to materially increase the number of non-commissioned officers, the want of whom was becoming more and more apparent with all arms.

The general provisions of the scheme are as follows:—

A gratuity of 100 marks will be granted for the first re-engagement, which consists in the soldier undertaking to serve—irrespective of the arm to which he may belong—for a continuous total period of at least four years (four-year volunteers of cavalry for five years). The payment is made at the expiration of the soldier's legal period of service with the colours. Various classes are excluded from the benefit of the arrangement, notably those who have come from the non-commissioned officers' schools, officers' servants, regimental tradesmen, sick attendants, bakers, &c.

In the arms, active service with which has been fixed at two years, soldiers who complete this period of service on the date fixed for the transfers from the colours will be treated as if they had completed their legal term of active service.

From October 1, 1893, special provision for re-engaged men has been included in the establishment, a commensurate reduction being made in the number of lance-corporals. The established number of re-engaged soldiers may at any time be exceeded, provided vacancies amongst lance-corporals up to the number in excess be kept unfilled.

Training of Men not in Active Service.—In the Prussian army and in the contingents administered by Prussia the numbers called up, as stated below, include 10 per cent. of non-commissioned officers.

Infantry, from the Reserve	60,000	men
„ „ landwehr	60,000	„
Total	120,000	„
Field artillery, from men not in active service of the field artillery and cavalry	10,000	„
Foot artillery	5,000	„
Pioneers	3,000	„
Railway brigade	792	„
Train	5,630	„

The infantry reservists were exercised generally with the line troops, without being organized in special bodies; the landwehr men were trained in companies at the stations of the infantry.

For the cavalry men the training took place with the cavalry or field artillery regiments or with the train battalions.

The field artillery men were trained in special batteries with the field artillery regiments. The foot artillery were collected in companies and attached to battalions.

The pioneers, as a rule, were with the pioneer battalions.

In the train, special exercise companies were formed attached to the train battalions. Of officers those from the rank of second lieutenant to that of major were called up. The duration of the training was from 14 to 20 days, and took place between the 1st April and the enrolment of the recruits.

In Bavaria the numbers called up were: infantry, 17,000; field artillery and cavalry, 14,000; foot artillery, 700; pioneers, 665; and train, 1,190, including non-commissioned officers.

In Wurtemberg the training of the infantry and pioneers belonging to the reserve and landwehr did not take place on account of the extensive manœuvres held in the autumn.

Of the field artillery and cavalry, 500 men (including non-commissioned officers) were called up for special training, and 200 men of the train.

School of Musketry.—There were during 1893 three "information" courses, each for 22 lieutenant-colonels and majors, and one "information" course for 30 regimental commanders and field officers of equivalent rank, in which the whole of the Prussian Army Corps,

including the Hessian Divisions (25th), as well as the Saxon 12th Army Corps and the Wurtemberg XIIIth Army Corps, participated.

Of ordinary officers' courses of instruction there were four: 60 captains and 30 lieutenants attended each course. Non-commissioned officers' practice courses were held at the school of musketry and at the practice grounds at Arys and Munster, one at each; the whole number of non-commissioned officers that took part in them was 420.

The "information" courses lasted 14 days; they commenced in March and ended in September. The officers' courses of instruction lasted six weeks during the period from February to August; the practice courses took place during the same time, the non-commissioned officers being formed for the purpose into three practice companies at Ruhleben (Spandau), Arys, and Munster respectively.

Field Artillery Practice School.—Information courses were attended by regimental commanders and field officers as in previous years. The first course commenced on the 15th October instead of on the 1st as previously.

General Staff and Cavalry Tours.—General Staff tours took place in nine Army Corps, and in one, the 17th, a fortress General Staff tour was made. Each of the two Inspectors of cavalry supervised an extensive cavalry tour in which General and field officers of cavalry and commanders of mounted divisions of field artillery took part. Ordinary cavalry tours were also held in eight Army Corps.

Belgium.

Peace Establishments, Infantry.—Four divisions, with their quarters at Ghent, Antwerp, Liège, and Brussels respectively; strength, 1,921 officers, 28,810 men, 254 horses.

Cavalry.—Four brigades; located, 2 at Brussels and 2 at Ghent respectively; strength 368 officers, 5,744 men, 5,560 horses.

Field Artillery.—Four regiments; 2 at Ghent and 2 at Brussels.

Fortress Artillery.—Four regiments; 2 at Antwerp and 2 at Liège.

There are, further, 4 special artillery companies and 5 special pioneer companies. Total strength of artillery, 616 officers, 8,309 men, 2,922 horses, 204 guns.

Engineers.—1 regiment at Antwerp; strength, 152 officers, 1,433 men, 17 horses.

War Strength.—On mobilization the following formations are completed:—

Four Army Divisions, each of 12 battalions (the 1st and 2nd divisions have, in addition, each 1 rifle battalion), 2 squadrons of cavalry, 7 batteries of field artillery (the 1st and 4th divisions have 8 batteries), 1 engineer company, and 1 train company. The auxiliary formations with each army division are 1 administrative company, 1 section field telegraphs, 1 administrative detachment, 2 artillery and 2 infantry ammunition columns, 1 section engineer park, 1 sanitary detachment, 2 field hospitals, 2 provision columns, and 1 horse depôt.

Two Cavalry Divisions, each of 16 squadrons, with 2 horse artillery

batteries. Each division has attached to it 1 subdivision of a train company, 1 artillery ammunition column, 1 administrative detachment, and 1 sanitary detachment.

Fortress Troops.—For the mobile defence of—

Liège, 4 active battalions and 2 squadrons.
Namur, 2 active battalions and 2 squadrons.
Antwerp, 1 active and 10 Reserve battalions, 4 squadrons cavalry, 6 Reserve field batteries.

The scheme does not provide for the cavalry being formed until the mobilization takes effect.

For actual garrisons of the above-named places, 28 reserve battalions, 4 fortress artillery regiments, and 12 engineer companies; also 1 fortress telegraph company, 1 company of artificers, 1 fortress pontoon company, and other special formations.

Ersatz Troops.

19 infantry detachments.
8 cavalry detachments.
4 field artillery detachments.
4 fortress artillery detachments.
1 train detachment.
1 engineer detachment.

Strength on War Footing.

Field army			72,932	men.
Antwerp	garrison	20,833	30,916	,,
	mobile troops	10,083		
Liège	garrison	4,843	8,949	,,
	mobile troops	4,106		
Fortress troops:—				
Namur	garrison	4,810	6,882	,,
	mobile troops	2,072		
Termonde			4,427	,,
Diest			2,642	,,
Guy			586	,,
Ersatz troops			3,978	,,
Total			131,312	,,

Organization.—The services of railways, posts, and telegraphs in the field have been regulated by a decree, and during peace-time a mixed committee of officers and civilians has been formed, and also a sub-commission for transports.

1st. This standing committee has to decide upon the laying-out of new lines of rail, on the construction of railway bridges, aqueducts, and buildings of a like nature, also upon the alteration of existing lines.

2nd. The sub-committee regulates the line transport in peace.

3rd. The field-railway, post, and telegraph services are so regulated that a superior official, with the necessary staff, from each of these branches is attached to the officer in command, and acts according to the direct instructions given by him. Of the 7 field post offices, 1 is allotted to headquarters and 1 to each of the 4 army and 2 cavalry divisions.

Formation of Divisions of Artillery.—The active batteries of the field artillery have been formed into divisions of 3 batteries each, except that in the 1st and 4th regiments the 3rd division consists of 2 batteries only. The horse artillery batteries have been formed also into 2 divisions, each of 2 batteries, belonging respectively to the 2nd and 4th regiments.

Experiments in Entraining and Detraining Troops.—Some interesting trials were made with various units:—

1st, a Battalion.—Composition: 20 officers, 1,020 men, 28 horses, 1 ammunition, 3 baggage, and 1 provision wagons. Railway matériel: 4 horse and 16 specially-fitted wagons for men, 3 carriages 3rd class, 2 1st and 2nd class, 1 truck for transport of ramps, 1 wagon for the railway officials, 2 engines. The entraining by day in the station took 37 minutes; detraining by night in the open 40 minutes, in the station 20 minutes.

2nd, a Squadron.—Composition: 5 officers, 100 men, 170 horses, 2 vehicles, 1 field forge, and 1 foraging cart. Railway matériel: 22 horse and 1 adapted men's wagons, 2 open trucks for the vehicles, 1 for the ramps, 1 carriage (1st and 2nd class), 1 for the railway officials, 2 engines.

To entrain by day in the station with 3 firm ramps required 52 minutes, the horses alone 32 minutes; by night in the open the time taken was an hour and 18 minutes, the horses alone 57 minutes. To detrain in the open by day required 1 hour and 15 minutes; at the station by night 57 minutes.

3rd, a Battery.—Composition: 5 officers, 166 men, 154 horses, 6 guns, 9 ammunition wagons, 1 reserve limber, 3 carts, and 1 field forge. Railway matériel: 20 horse wagons, 11 open trucks, 1 fitted men's wagon, 1 truck for bridges and ramps, 1 carriage for the railway officials, 2 engines. The entraining in the station by day, using 2 platforms, which allowed of the simultaneous entrainment of horses, wagons, and men, occupied 1 hour and 35 minutes; at night in the open 1 hour 20 minutes. To detrain by day with the train divided into 2 portions of 150 m. required 1 hour and 8 minutes; at the station by night 1 hour.

4th, an Infantry Ammunition Column.—Composition: 2 officers, 102 men, 156 draught horses, 1 officer, 25 men of infantry, 4 gunners, 1 battery cart, 1 field forge, 21 ammunition wagons. Railway matériel: 5 passenger carriages, 20 horse wagons, 16 open trucks (1 of which for flying bridges and ramps), 1 carriage for the railway officials, 2 engines. Entrainment and detrainment occupied each 1 hour and 30 minutes.

5th, a Provision Column.—Composition: 1 officer, 33 men, 103

draught horses, 1 officer, 31 men of the administration, 9 provision wagons of 3,250 kilos., and 15 supply wagons of 2,500 kilos. The entrainment in the station occupied 1 hour 20 minutes, in the open 1 hour 15 minutes; the detraining in the open 2 hours 15 minutes, in the station 2 hours 20 minutes.

Bulgaria and East Roumelia, 1892–93.

Peace Composition.—The active army is formed in 6 army divisions, the headquarters of which are at Sofia, Philippopel, Slivno, Schumla, Rustchuk, and Widdin respectively. The composition of each division is similar as regards infantry, of which there are 4 regiments of 2 battalions each per division, and as regards artillery, of which each division has 1 regiment of 5 field batteries and half a mountain battery. The cavalry is distributed 1 divisional sotnia to each of the divisions, 1 cavalry regiment of the line each to the 1st, 2nd, 3rd, and 6th divisions, and a lifeguard squadron with the 1st division. The 4 line regiments form a cavalry division, the staff of which is at Sofia.

There are 3 battalions of pioneers, belonging respectively to the 1st, 4th, and 5th divisions, 1 railway company, and 1 telegraph company, both with the 1st division; also 1 pontoon company with the 5th division. These 3 pioneer battalions and 3 special companies form a brigade, having its staff at Sofia.

The fortress artillery consists of 2 battalions, each of 3 companies, 1 is with the 1st division, the other with the 6th.

There are a train company and a sanitary detachment with each division.

Strength in Peace.—By the budget for 1893 the following is the strength by arms:—

Arm.	Officers.	Non-commissioned officers and men.	Service horses.	Horsed guns.
Infantry	1,614	24,047	994	—
Cavalry	173	3,579	3,582	—
Artillery	330	6,492	2,578	132
Pioneers	82	1,783	56	—
Together	2,199	35,901	7,210	132
Total		38,100		

The above establishments were, however, not reached during the year; they were kept about an average strength of 9·5 less, from motives of economy it is believed. For 1894 the total establishment has been fixed at 35,919 men.

Constitution for War: 1st, the Field Army is composed of 6 divisions, each consisting of the following formations:—

Infantry, 4 regiments each of 4 battalions.
Pioneers, 1 battalion.
Artillery, 1 regiment, comprising:—

5 field batteries of 8 guns
1 mortar battery of 6 guns } together 52 guns.
1 mountain „ „

Divisional cavalry, 2 squadrons.
Field gendarmerie, 1 squadron.
Train „ 1 battalion.
Sanitary detachment, 1 company.

There are, further, the sanitary transport, divisional field hospital, supply detachment, and a half company of etappen gendarmerie.

The 6 divisions together include the following units:—

Infantry, 120 battalions.
Pioneers, 6 „
Artillery, 30 field batteries, or 240 guns.
6 mortar batteries, or 36 mortars.
6 mountain batteries, or 36 guns.
Divisional cavalry, 12 squadrons.
Train, 6 companies.
Sanitary service, 6 companies.

There are, further, a cavalry division of 2 brigades, each of 2 regiments, viz., 4 regiments of 5 squadrons, or 20 squadrons, 1 squadron of the Prince's Bodyguard, and 3 battalions, or 12 companies, of fortress artillery.

The field army has the following special establishments and services: 1 telegraph park, 1 pontoon park, 1 railway company, 1 park company, 2 artillery parks, 1 central etappen hospital, etappen hospitals, 2 movable artillery workshops, 2 movable artillery depôts, 1 horse remount depôt, 1 evacuation committee, 1 chief supply administration, etappen command establishments.

Bodies of troops larger than divisions are not provided for beforehand, but the establishments mentioned above admit of their formation.

2*nd. The Reserve Army* (*Landwehr*).—This is composed equally with the field army of 6 divisions, each consisting of:—

Infantry, 4 regiments of 4 battalions.
Artillery, 1 regiment of 6 field batteries of 4 guns, 1 mountain battery of 4 guns; total, 28 guns.
Divisional cavalry, 2 to 3 squadrons.
Pioneers, 1 company.
Train, 1 battalion.
1 divisional hospital and 1 supply detachment.

The 6 reserve divisions together comprise the following units:—

Infantry, 96 battalions.

Artillery, 36 field batteries, 6 mountain batteries; total, 168 guns.
Cavalry, 12 to 18 squadrons.
Pioneers, 6 companies.
Train, 6 battalions.
6 divisional hospitals and 6 supply detachments.

There are besides 1 artillery park, 1 movable artillery workshop.

3*rd. Landsturm.*—The 1st and 2nd levy each form 24 Landsturm battalions of from 3 to 5 companies. The battalions of the 1st levy are organized in 6 regiments of 4 battalions, those of the 2nd levy have no organization higher than the battalion. The other arms have no existence.

4*th. The Ersatz Troops for the Field and Reserve Armies:*

Each line regiment, 1 battalion, 1 squadron, and 1 battery.
Each reserve regiment, 1 company, 1 subdivision cavalry, and 1 subdivision of a battery.

Strength of mobilized Forces.

Formation.	Men.	Horses.	Guns.
Field army	120,000	5,850	312
Reserve army	96,000	2,700	186
Landsturm	48,000	—	—
Total	264,000	8,550	498

That is about 8 per cent. of the population.

New Formations.—The existing organization of the Bulgarian Army is based on the law of December, 1891. This was given effect to in 1892 to the extent of forming 3 companies in cadre for the 24 reserve regiments—the cadres consisted of from 7 to 9 officers and 84 men per regiment—and of creating 3 of the 6 reserve batteries. The remaining 3 batteries were formed in 1893. The strength of each battery is 7 officers and 204 men.

Of cavalry, 6 independent divisional formations were created, each consisting of 5 officers and 148 men.

Changes in Establishments and Formations.—The establishment of an infantry regiment was fixed at 50 officers, 6 surgeons and officials, and 898 men; of a cavalry regiment at 25 officers, 6 surgeons, &c., and 649 men; of an artillery regiment at 31 officers, 5 surgeons, &c., and 663 men.

A change was made in the artillery regiments, which, up to 1892, were composed of 4 batteries of field artillery and a subdivision of mountain artillery. An addition has since been made of 1 field and 1 mortar battery to each regiment, and the subdivision of mountain artillery increased to a half battery. At present, consequently, each

of the 6 artillery regiments consists of 5 field artillery batteries (of 8·7 and 8 cm. calibre) of 4 guns in peace and 8 in war, 1 mortar battery (12 cm.) of 6 guns, and half a mountain battery with 3 guns, which in war would be augmented, and form a whole battery with 6 guns.

The establishment of the fortress battalions is fixed at 12 officers, 2 officials, and 329 men; of the sanitary companies at 1 officer and 59 men.

The distribution of the Bulgarian Army is kept secret, on account of Servia, and no official publication on the subject is available. But from trustworthy private sources the following appear to have been the stations of the army at the commencement of 1893:—

Infantry.

No. 1	Regiment....	Sofia.
2	„	Tirnova.
3	„	Widdin.
4	„	Plevna.
5	„	Rustchuk.
6	„	Sofia.
7	„	Schumla.
8	„	Varna.
9	„	Philippopel.
10	„	Hässkoj.
11	„	Slivno.
12	„	Stara Zagora.
13	„	Kustendil.
14	„	Staff and 1 battn. Radomir.
		1 battn. Tzaribrod.
15	„	Staff and 1 battn. Widdin.
		1 battn. Belgradschik.
16	„	Staff and 1 battn. Plevna.
		1 battn. Lovtscha.
No. 17	Regiment..	Staff and 1 battn. Rustchuk.
		1 battn. Silistria.
18	„ ..	Tirnova.
19	„ ..	Schumla.
20	„ ..	Varna.
21	„ ..	Staff and 1 battn. Hermanly.
		1 battn. Peschtera.
22	„ ..	Staff and 1 battn. Tatar Bazardjik.
		1 battn. Stanimaka.
23	„ ..	Staff and 1 battn. Kazanlik.
		1 battn. Stara Zagora.
24	„ ..	Staff and 1 battn. Burgas.
		1 battn. Jamboly.

Cavalry.

No. 1	Regiment....	Sofia.
2	„	Lom Palanka.
3	„	Philippopel.
4	„	Jamboly.

Artillery.

No. 1	Regiment....	Sevlievno.
2	„	Bratza.
3	„	Philippopel.
4	„	Sofia.
5	„	Schumla.
6	„	Slivno.

Recruiting Areas.—The distribution of recruits has also been rearranged in connection with the new law. Formerly this was very irregular, so that on the occasion of the last mobilization (1885) much friction was experienced. Now each of the 6 territorial division districts furnishes the men for the 4 infantry regiments, the 1 artillery regiment, 2 companies of pioneers, the 4 reserve regiments, and the 1 reserve battery. The infantry and the reserve regiment

are supplied exclusively from the area allotted to their number; the rest are completed from the entire divisional district. All the troops not mentioned above are supplied from the whole country. It is to be noted that during the last two years men have had to be taken from their own regimental area, and even from the divisional district, to complete units elsewhere.

Mobilization.—The preparations for mobilization, which in past years were very defective, have, during the period of office of the present War Minister, been completed, so that, in the event of a sudden order to mobilize, the Bulgarian Army would be found better prepared for it than any other army in the Balkan Peninsula. The mobilization would, in any case, be effected more rapidly and with less friction than was the case in the last war with Servia. The chief difficulties in carrying it out would lie in the large number of new formations to be created for war, and in obtaining the necessary number of horses.

FRANCE.

At the close of 1893 the total strength of the active army, including the augmentation by the newly-raised 14th Hussars and 31st Dragoons, the addition of 2 companies to 4 rifle battalions, and the reduction by the number of squadrons of the 2nd and 3rd Spahi regiments being changed from 6 to 5, was as follows:—

Infantry.

	Battalions.	Companies.
145 subdivisional infantry regiments, Nos. 1 to 144 and No. 160, each of 3 battalions, and 1 supplementary cadre	435	1,740
18 regional infantry regiments, Nos. 145 to 162, each of 4 battalions	72	288
30 rifle battalions, Nos. 1 to 30, of which 21 are of 6 companies and 9 of 4 companies	30	162
2 foreign regiments, each of 5 battalions and 2 depôt companies	10	44
4 Zouave regiments, each of 4 battalions and 2 depôt companies	16	72
4 Algerian tirailleur regiments, each of 4 battalions and 1 depôt company	16	68
5 battalions African light infantry, each of 6 companies	5	30
Total	584	2,404

Cavalry.

	Squadrons.
31 dragoon regiments, each of 5 squadrons	155
21 chasseurs „ „ „	105
14 hussar „ „ „	70
13 cuirassier „ „ „	65
6 Chasseurs d'Afrique „ „	30
4 Spahi regiments, 1 of 6 squadrons and 3 of 5 squadrons	21
Total	446

There are, besides, 8 companies, forming the remount establishment.

Field Artillery.

	Batteries.
19 regiments (divisional artillery), each of 12 field batteries	228
19 regiments (corps artillery), each of 9 field and 3 horse batteries	228
4 field batteries in Algeria and Tunis	4
12 mountain batteries in France	12
8 „ in Algeria and Tunis	8
Total	480

Foot Artillery.

	Batteries.
16 foot artillery battalions, each of 6 batteries	96
4 „ batteries in Algeria and Tunis	4
Total	100

Engineers.

3 regiments, each of 5 battalions and 1 train company.
1 „ 4 „ „
1 „ 3 „ „ (railway regiment).

Train.

12 squadrons, each of 4 companies, of which 12 companies are in Algiers and Tunis.
8 squadrons of 3 companies.
Total, 72 companies.

Distribution of Troops on the German Frontier.—As a result of the numerous changes effected during 1893 in the composition of the higher commands, the following was, at the close of that year, the distribution of troops in the 6th region, which comprises the departments of the Meurthe and the Moselle, Vosges, Aube, Ardennes, Marne, and Meuse, and a portion of the departments of the Seine and

Seine and Oise, with the subdivisional districts of Nancy, Toul, Neufchâteau, Verdun, Mézières, Troyes, and Châlons-sur-Marne.

6th Army Corps, Châlons:—

11th Infantry Division, Nancy.
12th „ „ Mézières.
6th Cavalry Brigade, Nancy.
6th Artillery „ Châlons-sur-Marne.
6th Engineer Battalion, Toul.
6th Train Squadron, Châlons Camp.

Under the commander of the 6th Corps, though not forming a part of that corps:—

39th Infantry Division, Commercy.
40th „ St. Mihiel.
Vosges Division, Remiremont.
The 2nd Cavalry Division, Lunéville.
The 4th „ Sedan.
Of the 3rd Cavalry Division, 2 brigades, Châlons.
„ 5th „ 1 brigade, Reims.
The 5th Infantry Brigade, detached from the 2nd Corps.
31 batteries of foot artillery.

Altogether, the troops in the 6th region amount to—

77 infantry battalions.
13 rifle battalions, 9 of which have each 6 companies.
110 squadrons.
37 field batteries.
11 horse artillery batteries.
31 foot batteries.
1 engineer battalion.
1 train squadron.

Establishment.—Compared with 1893 there is an increase in the numbers fixed for the current year of 264 officers, 434 non-commissioned officers, and 12,361 men to the infantry, and of 135 officers, 106 non-commissioned officers, and 724 men to the cavalry.

Of the 460 field and horse artillery batteries, those belonging to the 6th Army Corps, the 2nd, 3rd, and 4th Cavalry Divisions, and some batteries of the 1st, 7th, 8th, 14th, and 15th Artillery Brigades, have each 6 guns and 3 ammunition wagons horsed; the remaining batteries have 4 guns and 2 ammunition wagons only.

Reserve Troops.—The units enumerated below are organized in peace and attached to the corresponding active formations entrusted with their administration and mobilization:—

145 reserve infantry regiments which have the number, augmented by 200, of the corresponding active regiments.
30 reserve rifle battalions, one to each existing active rifle battalion.

38 reserve cavalry regiments (dragoons, chasseurs, and hussars) formed with the line and light cavalry regiments of the corps cavalry brigades, and having the number augmented by 40 of the corresponding active regiment.
41 reserve cavalry squadrons formed with the regiments belonging to cavalry divisions.
216 reserve batteries of field artillery, 12 to each artillery brigade.

Territorial Army.—The number of formations of the territorial army, rolls of which, like those of the reserve army, are kept up in peace, and which are affiliated to the corresponding active formation, are as follows :—

To each of the 18 army corps in the interior :—

8 infantry regiments (9 with the 15th Corps).
4 to 8 squadrons of cavalry.
1 regiment of artillery.
1 engineer battalion.
1 train squadron.

To the 19th Army Corps :—

10 Zouave battalions.
6 squadrons.
13 batteries.

Additional to the 14th Army Corps—8 rifle battalions.
„ „ 15th „ 5 „
And of formations composed of customs and forest employés :—

38 battalions.
67 independent companies.
56 „ sections and detachments.

War Strength.—The publication "L'Année Militaire et Maritime" estimated the war strength of the French Army of trained soldiers at 4,372,000 men, made up as follows :—

Active Army { permanent portion.....	150,000	men.
Active Army { annual classes, 1888–90....	635,000	„
Reserve of the Active Army, 1881–87	1,320,000	„
Territorial Army and its Reserve, 1866–80	2,267,000	„

These numbers may be taken as approximately correct for 1893, though now there are 10 annual classes in the reserve and 6 in the reserve of the territorial army.

Organization.—The Bill referred to in the Annual Reports, 1892, for the constitution of the cadres and the effectives of the active and territorial armies, was passed and published as the law of the 25th July, 1893. In the report of the committee charged with the examination of the Bill the following appears :—"The law is really no 'loi des cadres,' although this designation has been introduced

owing to former legislation; it is a 'loi d'encadrement,' destined to consolidate our reserves and give them consistency.

"Since the reserve of the active army comprises three more annual classes, since the 'régiments mixtes,' which were composed of reservists and men of the territorial army, have been replaced by regiments of more even quality, the effective strength of our troops of the first line has been doubled. But the larger numbers alone do not suffice, they may even be a danger. When bodies of troops of great strength are not adequately furnished with leaders, they are wanting in flexibility and confidence; they represent a crowd of armed men, but not an army.

"The experiences at the manœuvres of 1892 showed that of the three battalions of the 'régiments mixtes' there was one battalion only that gave satisfactory results. This battalion was the one formed from the 'cadre complémentaire' of the line regiment. This superiority resulted solely and alone from the greater serviceableness of the cadres; the soldiers of these battalions were in themselves not superior to those of the other battalions. This incontrovertible fact indicates a defect and a weakness in our organization. We must provide our army in peace-time with a sufficient number of leaders, so as to do away with the difference in the efficiency of the reserve regiment as compared with that of the line without weakening or deteriorating the latter in the process."

The more important provisions of the law in question are the following:—

Article 1.—In regard to the composition of the cadres in the infantry, it is provided that the "cadre complémentaire" of the subdivisional infantry regiments shall be in 72 regiments 1 lieutenant-colonel and 1 battalion commander; in 73 regiments 2 battalion commanders, and in every regiment 8 captains and 4 lieutenants.

A "cadre complémentaire" is instituted for each regiment of Zouaves of 2 battalion commanders, 8 captains, and 6 lieutenants, and for each rifle battalion of 1 captain and 1 lieutenant.

Article 2.—The third lieutenant is done away with in the companies on the higher peace establishment, also the battalion adjutants.

Article 3.—All cavalry regiments are to be of 5 squadrons, with the exception only of the 1st Spahis, which has always 1 squadron in Senegal, and has, therefore, 6 squadrons.

Article 5.—The fortress artillery, at present 16 battalions, retains for the moment its existing strength; but so soon as the necessary men are available two new battalions are to be formed. A captain 2nd class is added to the establishment of each battalion.

Article 6.—The cadres of the field artillery are increased by 1 chef d'escadron and 3 captains, 2nd class, per regiment; 1 captain, 2nd class, per mountain battery, and 2 captains, 2nd class, per regiment of pontonniers.

Article 12.—Besides the formations of the territorial army already existing in each region the following are to be constituted:—

1 regiment of territorial artillery attached to the 19th artillery brigade.
1 train squadron (No. 19) attached to the 19th train squadron.
1 train squadron (No. 20) only to be called into existence on mobilization.

Article 13.—The units of the territorial army are attached to the corresponding units of the active army for administration, training, and mobilization.

New Formations.—Under authority of the law of the 25th July, 1887, the 14th Hussar regiment was formed at Alençon on the 16th October, and the 31st Dragoons at the Châlons camp on the 3rd November.

On the 16th October a new (7th) cavalry division was formed. It consists temporarily of only 5 regiments, distributed as follows:—

Staff of the Division, Meaux (provisionally).
1st Dragoon Brigade, Meaux:—
7th Regiment, Provins.
18th Regiment, Meaux.
13th Cuirassiers (attached).

6th Dragoon Brigade, Dôle:—
2nd Regiment, Auxonne.
19th Regiment, Dôle.

By presidential decree of the 12th December, the creation of two new companies for the 3rd, 5th, 18th, and 19th rifle battalions, stationed at St. Dié, Remiremont, Stenay, and Troyes, was ordered. The number of rifle battalions, therefore, with 6 companies, has risen from 17 to 21.

Marine Artillery.—The portion of this force located in France is to be employed in war to augment the army. It was given a new organization by a decree of the 8th July, and formed into two regiments in France, and a number of batteries in the Colonies, the number and organization of which are left to the Minister of Marine.

The two regiments together have 6 field batteries, 4 mountain batteries, and 13 foot batteries, the total strength of which is 147 officers, 2,742 men, 730 horses and mules. There are besides 5 companies of artificers, 21 officers, and 643 men, and 1 laboratory company, 5 officers and 130 men.

In the Colonies there are 14 batteries and 1 detachment.

The battalions of fortress artillery are in future to be designated battalions of foot artillery.

Recruiting Arrangements.—In 1892 the number of young men included on the lists as having become liable for service was 277,425, which was fewer by 22,882 than in the preceding year. There were also brought forward from previous years,

39,904 from 1890.
20,090 „ 1891.

25,884 were passed over as totally unfit for service, 8,752 did not present themselves.

There had further to be deducted

40,167 postponed.
82 excluded on account of unworthiness.
20,295 allotted to the military auxiliary services, and those who had entered the army as volunteers.

The net number enrolled, including those brought forward from the years 1890 and 1891, was 181,872. The number of these men who could neither read nor write was 19,547, or 7·05 per cent., and the average height 5 feet 4·77 inches, a fraction less than the preceding year.

The number of men who enlisted voluntarily during 1892 was 31,795, including 5,790 in the foreign and Algerian formations. Of those who entered the navy and the formations within France, the term of voluntary engagement was

7,023 for 3 years.
15,602 „ 4 „
3,380 „ 5 „

Mobilization, Superior Staffs.—On the 6th March, 1893, new instructions were issued respecting the composition of the staffs in war. The most important provisions were the following:—

In war with the mobilized army are:

1st. The Grand État-Major-Général with a Major-General, some Aide-Majors-Généraux, and the necessary personnel.
2nd. In each army an état-major-géneral with a General as chief, and 15 officers.
3rd. In every army corps a staff consisting of a colonel, or a lieutenant-colonel, as chief; 1 lieutenant-colonel or commandant, as second; 1 superior officer, 2 captains of the general staff, 3 officers in possession of the brevet d'état-major, 2 orderly officers, 1 interpreter, 1 archivist, 6 mounted orderlies, 4 non-commissioned officers of infantry as orderlies, 4 cyclists, and 10 clerks.
4th. Staff of an infantry division, 1 chief, 2 general staff officers, 1 orderly officer, 1 interpreter, 6 mounted and dismounted orderlies, 4 cyclists, 4 clerks.
5th. Staff of a cavalry division, the same as an infantry division, except that there is 1 general staff officer and 1 captain of engineers more, and 1 clerk less.
6th. Staff of an infantry brigade, 2 orderly officers, 2 cyclists, and 3 clerks.

The Grand Quartier Général of a group of armies is composed as follows:—

1st. The Commander, with his orderly officers and military cabinet to deal with personal matters concerning officers.

2nd. The Great General Staff.

3rd. General directions for railways and lines of communication, with a committee for the utilization of waterways for military purposes.

4th. The officers placed under the major-general (chief of the staff) for the direction of the artillery, the engineers, and of the intendance, the sanitary, telegraph, and postal services.

5th. Internal services connected with headquarters, viz., the intendance, telegraph detachment, the post, the printing establishment, and the gendarmerie.

6th. The civilian personnel attached to headquarters.

7th. The escort: 1 company of infantry, 1 squadron of cavalry, 1 train detachment.

The headquarter establishments of other superior commands are as follows:—

Headquarters of an Army.

1st Group:—

	Officers.	Men.	Horses.	Vehicles.
1. Commander and General Staff ..	16	70	81	19
2. Escort, 1 peloton of cavalry	1	29	33	1
3. Direction of the telegraph service	2	4	5	1
4. Printing press	—	4	2	1
5. Gendarmerie	—	10	5	—

2nd Group:—

1. Commander of artillery and staff.
2. ,, engineers ,,
3. Intendance with an army intendant and staff.
4. Sanitary service, with a médecin inspecteur and personnel.
5. Veterinary service.
6. Postal service.
7. Service of military justice.
8. Field police and gendarmerie.
9. Escort, 1 peloton of cavalry.
10. Headquarters provisions park.
11. Telegraph section of the 1st line—4 officers, 76 men, 48 horses, 12 vehicles.
12. Train detachment—38 officers and officials, 259 men, 215 horses, 40 vehicles.

3rd Group (*Direction of the Lines of Communication*):—

1st. Staff of the etappen direction, with a Brigadier-General, sous-chef of the General Staff, and personnel, 7 officers, 26 men, 27 horses, 3 vehicles.

2nd to 9th. The different branches of the etappen direction, in all, including the Staff above, 27 officers, 77 men, 60 horses, and 4 vehicles.

The total strength, therefore, of the headquarters of an army is 84 officers and officials, 449 men, 401 horses, and 60 vehicles.

For an army corps the headquarter establishment is 55 officers

338 men, 287 horses, and 43 vehicles; for an infantry division 20 officers, 111 men, 94 horses, and 10 vehicles.

The duties in the mobilized staffs of army corps and larger bodies are divided into three branches, to each of which certain subjects are allotted, viz.:—

1*st branch.*—Personnel and matériel, organization, establishments, losses, drafts to maintain strength, ammunition, supply, and general correspondence.

2*nd branch.*—Intelligence service, political affairs, situation, organization and movements of the enemy's troops, service of interpreters and correspondents, bearers of flags of truce, prisoners of war, regulation of relations with the officers, &c., in occupied territory.

3*rd branch.*—Operations, marches, parole and countersign, diary of operations.

It is worthy of attention that it is officially laid down that when marching a General Staff officer is always to be at the point initiate, that is, at the place where the troops join the column of march. One officer of the Staff is detailed to have charge of the internal service of the headquarters, to whom the commander of the escort is permanently attached.

The headquarters of an infantry brigade is composed of 3 officers, 12 men, 10 horses, and 1 vehicle; that of a cavalry brigade of 3 officers, 10 men, 12 horses, and 2 vehicles.

In peace the duties of the Staff are grouped in two sections.

In the 1st (active section) are:—

General correspondence.
Training and manœuvres.
Personal questions.
Military justice and administration.

In the 2nd (territorial section):—

Organization.
Mobilization.
Recruiting.
Reserve and Territorial Army.
Territorial affairs.
Establishments and fortifications.

Detailed instructions are given respecting the composition and subdivision of orders; those for example relating to marches must contain:—

1st. General situation and information regarding the enemy.
2nd. Dispositions respecting own measures.
3rd. Employment of the cavalry.
4th. General arrangements for the march.
5th. Measures of security and communication with neighbouring columns.
6th. Place of headquarters in the column.

The foregoing particulars form the first part of the order, which must be imparted to commanders as early as practicable directly, it has been drafted.

The second portion of the order: directions concerning cantonments, outposts, movement of the train, supply, employment of telegraphs, sanitary and postal services can be issued later, separate from the other part.

Preparations for Mobilization in the Infantry.—By Article 13 of the law of the 28th July, 1893, the administration and the preparation of the mobilization states of the territorial infantry regiments are vested in the corresponding active regiments. Further details are given in a decree from the War Ministry, dated the 11th November. The duties with which the captain-major of the territorial regiment has been entrusted hitherto are transferred to the active infantry regiment, which acquaints the commander of the territorial regiment with all measures taken and with the distribution of the officers. The mobilization of the territorial regiment is effected with the active regiment. The "conseil d'administration" of the active regiment acts equally for the territorial regiment. If the latter is called up for exercise or is mobilized, 1 lieutenant and 2 or 3 clerks are to be detached from the territorial regiment to the clothing officer and to the paymaster. Similar arrangements are made for rifle battalions, with which the formation of territorial rifle battalions takes place.

The administration and mobilization of the artillery and train formations have also been entrusted, since the 1st January, 1894, to the active portions of these arms.

In each region the preparations for the mobilization of the territorial artillery regiment are made by the artillery staff of the local army corps, for which purpose an active captain of the 2nd Class, with the necessary clerical staff, are attached to it.

Company Ammunition Wagons.—The supply to every company of an ammunition wagon carrying 65 rounds per man and intrenching tools has now been completed. The battalion ammunition wagons and the pack mules for carrying the tools have been done away with.

Gun Ammunition.—All field and horse artillery batteries carry shrapnel as a uniform projectile and a few rounds of case, viz.:—

The 80 mm. horse artillery batteries with the corps artillery, 912 shrapnel, 24 case.

The 80 mm. horse artillery with cavalry divisions, 828 shrapnel, 24 case.

The 90 mm. batteries with ammunition wagons, M 1840, 846 shrapnel, 24 case.

The 90 mm. batteries with ammunition wagons, M 1880, 825 shrapnel, 21 case.

The 80 mm. mountain batteries, 773 shrapnel, 67 case.

Including the supply in the ammunition and park sections.

The 80 mm. batteries have 1,834 rounds, or 305·6 per gun.
„ 90 „ „ „ 1,531 „ 255·1 „

Regulations for the Sanitary Services in the Field.—New regulations were issued in July, 1893; they comprise 7 sections, containing 124 paragraphs.

1st Section.—General Instructions.

1st chapter. Organization of the sanitary services in the field.
2nd „ Conduct of the sanitary services and official relations of these to the commanders.
3rd chapter. Working and organization of the sanitary service with bodies of troops and the sanitary formations to be created in the event of war.

2nd Section—Advanced Service.

1st chapter. Duties and organization.
2nd „ Directions regarding the sanitary service with regiments, &c., on the march, when halted, and in action.
3rd chapter. The same with the ambulances.
4th „ „ „ field hospitals.

3rd Section.—Service in Rear.

1st chapter. Duties and organization.
2nd „ Directions for the service of temporarily stationary field hospitals.
3rd chapter. Sanitary establishment in occupied territory.
4th „ Directions for the service of evacuation hospitals.
5th „ The same for railway station hospitals and sick rooms.
6th chapter. The same on the lines of communication.
7th „ Organization of convalescent depôts.
8th „ Sick transport by land, water, and rail.
9th „ Distribution of the sick and wounded in the interior.

4th Section.—Sanitary Material.

1st chapter. Constitution and completion.
2nd „ Administration and preservation.
3rd „ Keeping of accounts, &c.

5th Section.—Sanitary Services in Fortress Warfare.

1st chapter. In the attack of a fortress.
2nd „ In a besieged fortress.

6th Section—Voluntary Care of Sick.

Organization and sphere of operations of the Société d'Assistance aux Blessés et Malades Militaires.

7th Section.—Sanitary Services in the Interior during a Campaign.

The following shows the several sanitary establishments with each army corps:—

	Medical officers.	Administrative officer.	Hospital attendants.	Sick bearers.
1 direction of the sanitary services	2	1	3	—
2 directions with the 2 infantry divisions, each having.....	1	—	1	—
1 headquarter ambulance as reserve, and for army corps troops.....	6	—	30	98
2 divisional ambulances.....	6	—	30	98
1 cavalry brigade ambulance....	2	—	16	—
8 field hospitals, each with	4	—	36	—
There are further—				
With each infantry regiment ...	1	—	—	—
„ „ battalion ...	2	—	—	1 corporal
„ cavalry regiment	2	—	4	—
„ infantry company....	—	—	1	4
„ field artillery group..	2	—	1	—
„ field battery	—	—	—	4

The whole of the personnel for field hospitals Nos. 5 to 8 is found by the Reserve and Territorial Army. The ambulances form part of the fighting train.

Reservists called up for Training.—The men "en disponibilité" of the 1889 yearly class were out for four weeks, from the 21st August.

The Reservists of the 1883 and 1887 classes belonging to the regional infantry regiments of the rifle battalions in the sphere of the 14th and 15th Army Corps, and of the tirailleur regiments for four weeks, from the 21st August.

The Reservists of the 4th, 5th, and 6th battalions and of the section "hors rang" of the Reserve infantry regiments, of the Reserve rifle battalions, of the 4th, 5th, and 6th depôt companies of the subdivisional regiments, and of the 2nd depôt company of the active rifle battalions (with the exception of the battalions in the sphere of the 14th and 15th Army Corps) of the 1883 and 1887 classes.

The Reservists of the Active and Reserve cavalry regiments of the above classes in four series of four weeks each at different times.

The Reservists of the same classes belonging to the artillery, pontonniers, and train for four weeks at different times. Also those of the Engineers for a similar period from the 21st August.

The whole number provided for in the Estimates was 5,603 officers and 346,625 men, viz.:—

	Officers.	Men.
Infantry	4,370	232,272
Administrative troops.....	—	20,753
Cavalry.....	375	15,092
Artillery.....	600	54,295
Engineers.....	158	6,959
Train.....	100	17,254
Total.....	5,603	346,625

General Staff Tours and Cadre Exercises.—In 1893 there were General staff tours in nine Army Corps. By an instruction of the 17th March, cadre exercises were ordered for the whole of the infantry divisions, and it was left to the discretion of the General officers commanding them to have similar exercises by brigades. They are carried out under the superintendence of the division or brigade commander, and the following officers take part in them:—In the divisional exercises the commander of each brigade with his orderly officer, 3 field officers from each infantry regiment, 1 field officer of cavalry, the commander of the divisional artillery, 1 other artillery officer, and a captain belonging to the engineers; in the brigade exercises 3 field officers and 3 captains from each infantry regiment, and 1 field officer or captain from the cavalry and the artillery.

In nine army corps districts, also, cadre exercises of a reserve division or brigade were held. Similar exercises were held by the 1st, 3rd, and 4th cavalry divisions and the 6th Dragoon Brigade.

The duration of the divisional exercises was 5 days; of the brigade ones 4, not including the time of marching to and fro.

Greece.

Peace Organization.—The armed forces are distributed in three General commands, the headquarters of which are at Larissa, Missolonghi, and Athens respectively.

The 1st command comprises 3 regiments of infantry, 10 battalions (including 4 light battalions) of 40 companies, 1 cavalry regiment of 4 squadrons, and 1 field artillery regiment with 4 field batteries, and 3 mountain batteries.

The 2nd command includes 3 regiments, 8 battalions (including 2 light battalions) of 32 companies, 1 regiment of cavalry of 4 squadrons, and 1 field artillery regiment with 3 field and 3 mountain batteries.

The 3rd command has 4 infantry regiments, 10 battalions (including 2 light battalions) of 40 companies, 1 cavalry regiment of 4 squadrons, 1 field artillery regiment with 4 field and 3 mountain batteries, 1 engineer regiment of 2 battalions of 8 companies, and a telegraph company.

There is, further, a train company distributed amongst the 8 supply depôts, and a sanitary company divided amongst the 8 hospitals. There are also 16 gendarmerie detachments, 3 in the 1st district, 6 in the 2nd, and 7 in the 3rd, the men for which are taken from the line troops and borne on their strength.

The following is the peace establishment of the several arms, not including the higher commands, officials, institutions, &c.:—

Arm.	Officers.	Other ranks.	Horses and mules.	Horsed guns.
Infantry	857	15,182	202	—
Cavalry	93	1,053	739	—
Artillery	222	2,056	862	120
Engineers	101	1,112	72	(and 66 ammunition wagons)
Train and sanitary .	206	295	30	
Gendarmerie	143	3,086	383	
Total	1,622	22,784	2,288	120 (66 ammunition wagons)

During 1893 these establishments were never complete; the strength varied generally from 16,000 to 18,000 men. In the late summer and autumn the calling up of men on long furlough to suppress brigandage on the Turkish frontier raised the strength to about 22,000 of all ranks.

On mobilization for war the General commands are converted into army corps, each of which has the following constitution:—Infantry, 2 brigades of 5 regiments, 18 battalions (including 3 light battalions), 72 companies; cavalry, 1 regiment of 5 squadrons; artillery, 2 regiments of 7 field and 3 mountain batteries; engineers, 1 battalion of 4 companies, 1 telegraph company, 1 train battalion, and 1 sanitary company.

Thus there would be 3 army corps having 6 infantry brigades of 9 battalions each, 3 cavalry regiments, 6 artillery regiments, 3 engineer battalions, 3 telegraph companies, 3 train battalions, and 3 sanitary companies.

Of these units, however, the following have to be formed on mobilization:—15 infantry and 1 light battalion, 3 squadrons, 1 engineer battalion, 2 telegraph companies, 2 battalions, and 3 companies of train, and 3 sanitary companies.

The war strength of the several arms would be in round numbers as follows:—

Infantry....	54,000	men,	
Cavalry	2,250	,,	
Artillery....	4,000	,,	180 guns, 126 ammunition wagons.
Engineers ..	3,000	,,	
Train, &c...	3,000	,,	
Total	66,250	,,	

or about 3 per cent. of the population.

Under the most favourable conditions the above numbers could only be attained in the course of from 8 to 10 weeks. But there can be no confidence that they would be forthcoming, even after this lapse of time, for the defects in the machinery for mobilization which

were so obvious in 1885–86, when the Greek army was last mobilized, have never been remedied. On that occasion it was estimated that of those recalled to the colours no less than 23,000 men failed to put in an appearance.

So long as this state of things is possible, no great dependence can be placed on the results of a future mobilization. The training of the troops leaves much to be desired.

Great Britain.

Mobilization.—The 1892 instructions for mobilization have during the past year been so extended that it is now possible to obtain a complete picture of the mobilization; that the Militia and Volunteers, as well as the Yeomanry, have been given a distinct place in the defence of the country may be regarded as a special mark of progress.

In regard to mobilization a distinction has to be made between
1st, general mobilization for war abroad;
2nd, general mobilization for home defence;
3rd, partial mobilization for war abroad.

General Mobilization for War Abroad.—Having regard to the probable theatres of war, preparations cannot be made beforehand in every particular. In the event of imminent national danger, and in case of necessity, the reserve can be employed for the reinforcement of the field army, otherwise the troops remaining immobilized, the depôts have to provide for keeping the force before the enemy completed. The decision respecting the calling out of the reserves rests with the Cabinet, after communication to Parliament, if sitting, or if not sitting then by other notification. The officers charged with the inspection of the reservists have to take care, in concert with the local and parish authorities, that the order calling out the reserves is conspicuously posted at all public places, churches, town halls, and post offices. The reservists go to their depôts, where they are medically examined and clothed; they are then either forwarded to their corps or retained at the depôt. They receive their arms and equipment at their corps.

The Militia reserve is also available for the reinforcement of the army.

The second field equipment is stored at selected places in connection with the defence of the country. Tents carried in wagons are only employed in campaigns out of the United Kingdom.

Completion of Horses.—The requirement in riding and draught horses is 29,712, and 5,300 more are necessary for the line of communications service.

There are in England 14,757 service horses. Deducting these and 3,000 officers' horses from the 29,712, there remain about 13,000 new horses to be provided. These would be furnished from the reserve of horses numbering 14,000, which are inspected each year; the owners for an annual fee of 10*s.* per horse undertake to deliver it fit on

mobilization within 48 hours at an agreed price, or to pay a fine of 50*l.*

Of the 14,000 horses 3,500 are for riding purposes. Reception committees are provided for at 50 places to take over the horses; so that within 11 or 12 days from the notification of mobilization the horses can be in the hands of the troops.

Strength of the Material available.—Strength, 54 battalions, 11 cavalry regiments, 6 horse artillery, and 26 field batteries, 11 companies of engineers, 33 train companies.

There are required for the field army:—

	Infantry.	Cavalry.	Artillery.	Engineers.
	53,767	6,275	8,865	3,382
There are available:—				
Standing army in England	67,066	12,602	8,400	4,851
Army Reserve	55,907	5,396	5,000	1,876
Militia Reserve	24,780	—	2,000	426
Total men	147,753	17,998	15,400	7,153

On the 1st January, 1893, there were in Great Britain 71 battalions, 20¾ cavalry regiments, 11 horse artillery, and 42 field batteries, 41 engineer companies, and 40 train companies.

2nd. Mobilization for Home Defence.—In the elaboration of the mobilization scheme, the formation of the following groups is kept in view:—

(*a.*) Garrison and fortress troops (Militia and Volunteers with a few line troops).
(*b.*) The field army (3 army corps, 22 Volunteer field brigades, and 4 cavalry brigades).
(*c.*) Unallotted units.
(*d.*) Depôt troops.

Garrison and Fortress Troops.—In February instructions were issued regulating the distribution of these at home in detail to each fortress, harbour, and port the active defence of which is contemplated. The scheme provides for the employment in this service of the following:—

Regulars.—10 battalions, 31 companies of garrison artillery, 4 fortress companies, and 10 detachments of submarine miners (Royal Engineers).

Militia.—77 battalions, 194 companies garrison artillery, 21 fortress companies, and 15 detachments submarine miners (Royal Engineers).

Honourable Artillery Company.—4 companies.

Yeomanry.—17 squadrons.

Volunteers.—93 battalions, 13 batteries of position, 206 companies of garrison artillery, 67 fortress companies, and 19 detachments submarine miners (Royal Engineers).

Field Army.—The composition of the main portion of this force

was given in the *précis* of von Löbell's Reports for 1892 (p. 17). Notification has since been made of arrangements for the employment of 22 field brigades of Volunteers as a portion of the field army.

The composition of the several groups into which these brigades are combined, and the places of concentration of the groups, are as follows:—

2 brigades with 11 battalions, 4 60-pr., and 4 40-pr. batteries of position (32 guns) at Guildford.
3 brigades with 21 battalions, 3 60-pr., and 5 40-pr. batteries (32 guns) at Boxhill.
5 brigades with 35 battalions, 11 60-pr., and 10 40-pr. batteries (84 guns) at Caterham.
4 brigades with 32 battalions, 11 60-pr., and 5 40-pr. batteries (64 guns) at Halstead.
2 brigades with 12 battalions, 4 60-pr., and 4 40-pr. batteries (32 guns) at Tilbury.
4 brigades with 22 battalions, 4 60-pr., and 2 40-pr. batteries (24 guns) at Brentwood.
2 brigades with 13 battalions, 12 20-pr. batteries (48 guns) at Epping.

Thus provision is now made for the assembly around London of 3 army corps with 4 cavalry brigades and 22 field brigades of volunteers, together 55 line, 24 Militia, and 134 Volunteer battalions, 60 squadrons, 264 field guns, and 316 guns of position. The Yeomanry is formed into 16 field brigades of from 4 to 9 squadrons each, and allotted as divisional cavalry to the 9 infantry divisions. The Volunteer field brigades are not provided with cavalry or auxiliary services.

Unallotted Units.

Regulars, 10 battalions, 6 cavalry regiments, and 2 field batteries.
Militia, 31 battalions.
Volunteers, 5 battalions, 82 companies of garrison artillery, and 24 engineer companies.

A portion of the regular battalions may perhaps be destined to reinforce the Mediterranean garrisons.

Depôt Troops.—On mobilization, the infantry depôts would be expanded into 8 company battalions by means of reserve men and recruits; with this in view, there are kept at each depôt 500 rifles with sets of accoutrements. The cavalry at home have no depôts in peace-time; on mobilization a depôt would be formed by each regiment where it was stationed, at which, in the first instance, unserviceable men and horses would be left.

3. *Partial Mobilization for War Abroad.*—For the purposes of a minor war a portion of the army only, to be termed the field force, would be placed on a war footing. Its strength is calculated to be a division; but this need not prevent a smaller force being formed in case of necessity. If a larger force be required, the troops to be mobi-

lized would be the 1st Army Corps, a cavalry division, bridging troop, 1 field company Royal Engineers, staff, and half telegraph battalion, 1 field post detachment, and 1 balloon section. The normal field force has the following composition:—1 infantry division with a cavalry regiment, 1 cavalry brigade (12 squadrons), Royal Engineer staff, mounted detachment, bridging troop, 1 field company, ½ telegraph battalion, 1 field park, 1 balloon section, 2 horse artillery batteries, 1 cavalry division ammunition column, 2 sections of the ammunition park, 1 battalion of mounted infantry with machine-gun detachment; 2 signalling companies (1 mounted, 1 foot), 2½ train companies, 2 field bakery companies, 2 field hospitals, staff for base and line of communications, 1 infantry battalion, 1 war hospital, 1 base hospital, 2 companies ordnance store department, horse depôt, and 2 railway companies. Total establishment, 754 officers, 19,045 other ranks, 8,743 horses (eventually 6,000 in horse depôt), 30 guns, 10 machine-guns, 1,044 vehicles.

The personal equipment of the men and the first field equipment are kept at Aldershot, the second field equipment at Southampton, where the troops would embark.

Italy.

The army is distributed territorially in 12 army corps, of which one is allotted to Sicily. In war these army corps are uniformly composed of 2 infantry divisions (each of 2 brigades), 9 battalions (including 1 rifle battalion), 1 regiment of cavalry of 6 squadrons, 2 regiments of field artillery, 16 batteries of 6 guns, 2 engineer companies, and auxiliary services.

The Alpine troops, a part of the cavalry regiments, the mountain and fortress artillery, and the rest of the engineer regiments are outside the army corps organization. Cavalry divisions are formed of 2 brigades: 4 regiments, 24 squadrons, and 2 horse artillery batteries.

The mobile Militia forms 12 divisions of similar strength to those of the regular army; also various Alpine and engineer formations.

The territorial Militia forms 320 infantry and 22 Alpine battalions (75 companies), 100 fortress artillery, and 30 engineer companies.

Peace Strength.—Standing army: 14,397 officers, 511,788 of other ranks, and 1,242 horsed guns.

Mobile Militia: 5,298 officers, 207,630 other ranks, and 366 guns.

Special Sardinian Militia: 301 officers, 11,620 other ranks, and 12 guns.

Territorial Militia: 8,161 officers, 379,782 other ranks.

Of the foregoing categories the standing army and the mobile Militia are counted as field troops.

The number of men in the lists of those on prolonged furlough from the standing army and the mobile Militia has increased from 791,184 men on the 1st July, 1890, to 1,006,085 men on the 1st July, 1891. This rapid increase is the result of the law of 1891, and of an increased contingent of recruits during the last few years. The total

strength of the armed forces available on the 1st July, 1892, is officially stated to have been as follows:—

1st. Standing Army:—		
With the colours	229,511	
On furlough	594,442	
		823,953
2nd. Mobile Militia and Sardinian Militia:—		
Mobile Militia	504,396	
Sardinian Militia	20,772	
		525,168
3rd. Territorial Militia.....		1,640,322
Together.....		2,989,443 men

Mobilization.—The so-called "mixed mobilization system" has been now extended to the cavalry and the engineers, so that only the Grenadiers, the Alpine troops, the horse artillery, and mountain artillery are excepted from it. The Alpine troops and mountain artillery recruit regionally, that is, from fixed connected districts situated close together, and they are completed on mobilization from these. The Grenadiers and horse artillery are recruited and completed nationally, that is, from different districts of the whole kingdom. The other troops recruit nationally, but are completed regionally. They do not, therefore, receive back in principle the men trained by them. So as to carry out this system, separate completing districts are formed in the immediate neighbourhood of the garrisons of the cavalry, artillery, and engineers. These must necessarily occupy a considerable area, and a double method of enrolment has been adopted. Those reservists who reside in the immediate vicinity of the garrison report themselves direct to the units concerned; those in the more distant districts to the commanders of the district. The men of the infantry and bersaglieri are enrolled entirely at the headquarters of districts, and are forwarded from these to the regiments.

The whole of the units are in peace-time in possession of nominal rolls of the men to come to them, so that they are able to allot them beforehand to companies. The whole of the units leave depôts behind them. General Pelloux, the late War Minister, claimed that by the adaptation of the mixed system of mobilization its completion has been hastened by six days, and that it is as rapid in its operation as a completely territorial system.

The carbineers are mobilized and employed partly as military police and partly for the transmission of despatches, &c. As regards the Alpine troops, the mobilization both of the mobile and territorial Militia is entirely in the hands of regiments. The active companies have to be ready to march within a very few hours of receipt of the order to mobilize.

The cavalry has to receive both men and horses; but the regiment must be ready to march 24 hours after receiving the order to mobi-

lize. On the arrival of the men to complete, a reserve squadron is formed in each regiment.

In the artillery, single divisions or batteries march with their actual strength on receipt of the mobilization order, and receive their increment later. The mountain artillery looks after its entire mobilization itself. The field and mountain artillery can be ordered to provide for reserve formations, men of the 1st category to be employed as gunners, &c., and those of the 2nd category as train soldiers and mule drivers. The material for these formations is already in their possession. The mountain artillery may further be charged with the formation of special park animal depôts and siege parks.

Sanitary and supply companies are mobilized with the assistance of the district command. There is no separate train as a special formation, for the necessary units form part of the artillery and engineers.

Material for the Mobilized Army.—Clothing is available for all those men who would be required to take their places in the ranks on mobilization. Those liable for service in excess of that number would be clothed subsequently.

Of small arms there were available on the 23rd November, 1893, 1,625,000 converted Vetterli with new ammunition. Of the new rifle (6·5 mm., M/91) there were 50,000 issued to the Alpine troops, and 25,000 more ready for issue. For those issued the whole of the ammunition was in possession of the troops. Irrespective of any reserve supply, the number still required to complete the rearmament is 476,078. Of the cavalry carbine (M/91) 4,000 were ready; 19,754 more are required. The 9-cm. field guns and the mountain guns are practically new.

During the last three years the material of the fortress and coast artillery has been increased by more than 250 guns, amongst them some of the heaviest calibre and the latest construction. Ammunition for all the guns is available in the proportion laid down by regulation. Smokeless powder is being introduced for fortress guns of medium calibre; the muzzle-loading guns still mounted are being withdrawn and replaced by breech-loading guns; auxiliary apparatus, such as range-finders, &c., is plentifully supplied.

The Netherlands.

Organization.—In the course of the year proposals were made for regulating liability to service, and for service in the Militia and Schütterei. The principle of universal obligation underlies the scheme and replacement is consequently excluded. Every man on attaining 20 years of age is made liable for service either in the Militia or in the Schütterei, with certain specified exceptions. Those becoming liable are divided into two categories, of which the first forms the Militia, the second the Schütterei. Each year 11,500 men (of whom not more than 675 may be taken for the navy) are called up for the Militia. The terms of service are 6 years with the army,

1 year with the depôt reserve (the 7th), and 2 years with the Ersatz reserve (the 8th and 9th). The period of training (active service) is one year for foot soldiers, 18 months for those of the mounted branches. The militiamen can be called out for drill at most three times during the first six years of their service, and altogether for periods not exceeding 75 days.

In the Schütterei the period of service is 6 years, and 3 years in its reserve. The men are to be trained, as far as possible, at their own places of residence. Where this is not practicable, they would be called up for instruction either with a body of troops or at a special drill depôt. Besides this instruction, which comprises 120 drills of at most 2 hours' duration, or a period of 8 weeks if attached to a body of troops, the men can be called up twice subsequently for drill.

Institution of Reserve Cadres.—To supply the want of cadres for war formations, especially for the Schütterei, better than it was found possible to do from the Militia, the formation of reserve cadres for infantry and artillery has been authorized, from volunteers for such employment. These must be between 17 and 24 years of age, unmarried, and physically fit for service; they have to pass a literary examination, and are tested in handling arms. They have to serve 6 years and attend yearly certain drills until they become reserve officers.

Norway.

The armed forces are divided between three levies:—the line, the landwehr, and the landsturm. Each of these levies is composed similarly as regards arms and branches of the Service; the following is their composition:—

Infantry: 5 brigades of 4 corps, consisting each of 1 line, 1 landwehr, and 1 landsturm battalion, commanded by a colonel or lieutenant-colonel and 1 major. Each battalion has 4 companies. There are, further, 2 guard companies.

Cavalry: 3 corps, 2 of which have 3 squadrons and 1 two squadrons. There is also a squadron of orderlies.

Field artillery: 3 corps, each of 1 line, 1 landwehr, and 1 landsturm battalion, each of 3 batteries of 6 guns, and 1 artillery park company.

Fortress and mountain artillery: 1 corps in each levy of 1 battalion of 2 fortress companies, and 2 mountain batteries, each of 6 guns.

Engineers: 1 battalion of 4 companies in each levy, viz., 1 sapper, 1 pontoon, 1 telegraph, and 1 engineer-park company.

Train: 3 companies, which comprise all the annual classes.

Sanitary service: 3 corps, each of 1 line, 1 landwehr, and 1 landsturm company. Each company has the personnel for 5 ambulances and 1 sanitary detachment.

In peace the total strength of the army is about 12,000 men; in war it should be about 180,000 men and 800 officers.

Austria-Hungary.

The distribution of the forces in peace-time is in 15 territorial army corps, the military command of Zara in Dalmatia consisting of 2 infantry brigades and a regiment of fortress artillery, 9 landwehr commands of 1 infantry brigade of 3 regiments (that of Przemysl 2 only, of 9 to 12 battalions) and 1 regiment of cavalry (excepting those at Gratz and Prague), the land-defence commands at Innsbrück of 1 brigade of 4 regiments (13 battalions) and 1½ regiments of cavalry, and 7 Honved district commands, each of 2 brigades of 4 regiments (12 to 14 battalions), 3 of them, viz., Buda-Pesth, Szegedin, and Stuhlweissenburg, with a cavalry brigade of from 3 to 4 regiments.

Composition and Strength of the Mobilized Forces.—The 15 army corps comprise 31 infantry divisions, for the 2nd Corps at Vienna has 3 and the rest of the corps have 2. These form the 1st line troops, and to them have to be added 17 infantry divisions, formed 1 each in the several landwehr and Honved districts as 2nd line troops.

Of cavalry there are 18 brigades of the regular army, each of from 2 to 3 regiments, 3 of the Austrian landwehr of 2 to 3 regiments, and 3 of the Hungarian landwehr of 3 to 4 hussar regiments each; in all, 24 brigades. Of these, 16 are formed in 8 cavalry divisions, each of 2 brigades.

The artillery is formed in 14 brigades, comprising together 1,892 guns, of which 1,680 field, 92 horse artillery guns of 9 cm., and 120 mountain guns of 7 cm., calibre.

The landsturm formations constitute the 3rd line. The whole of these are mobilized, viz., 430 battalions and 30 squadrons. Of these battalions, 92 in Austria and 94 in Hungary are constituted as marching battalions; the remainder provide for the duties in the interior. Of the Austrian landsturm marching battalions, 72 are formed in 9 brigades, 20 are employed as staff and line of communication troops. In Hungary, 64 of the battalions are similarly formed in 8 brigades. The 30 squadrons are all Hungarian hussars, and are formed into divisions; eventually there will be also Austrian mounted landsturm formations.

The war strength of the 1st and 2nd lines, that is exclusive of the landsturm formation, is the following:—

	Officers and men.	Service horses.
Infantry and rifles	985,040	23,280
Cavalry	87,510	83,820
Field and mountain artillery	81,110 [1]	66,980
Technical troops, including pioneers, railway, and telegraph troops, and fortress artillery	53,000	2,900
Train and auxiliary services and establishments	89,710	56,590
Superior staffs, officials, and administration	19,000	—
Together	1,315,370	233,570

Organization. Austrian Landwehr.—In prosecution of the measures previously taken, especially in Hungary, in the endeavour to draw the landwehr into the 1st line and make the landwehr troops into field troops, the Austrian Government have increased the stringency of the landwehr law. That of December, 1893, provides in Article I that all those men who join the landwehr direct are to serve for two years with the colours. This was already the rule in the Hungarian landwehr, but in Austria the period of service was for one year only. Further, in order to ensure the presence with the landwehr of experienced non-commissioned officers, these have to serve for three years with the colours. To make up to them for this increased requirement they are subsequently granted certain advantages, the principal ones being that they are transferred to the landsturm after the first 10 years of their obligation to serve has been completed, and that they are released from the landsturm at 40 years of age instead of at 42.

Field Artillery.—Towards the end of 1893 preparations were made to carry out the reorganization of the field artillery, with a view to a considerable strengthening of this arm, and especially of the divisional artillery. After it has been completed there will be 14 corps artillery regiments, 42 divisional artillery regiments, and 1 mountain battery division. In the 56 regiments there will be 1,792 field guns, 96 horse artillery guns, 120 mountain guns, and 16 narrow-gauge guns; 60 Ersatz batteries will also be formed.

The corps artillery regiments are to be numbered as before from 1 to 14, and bear the name of the officer at the head of the regiment; the divisional artillery regiments the numbers from 1 to 42 without name. In every army corps (with the exception of the 15th) the corps artillery regiment bearing the same number and 3 divisional artillery regiments, which in principle are quartered at the stations of the infantry (or Landwehr) divisions to which they belong, form an artillery brigade bearing the number of the army corps.

The corps artillery regiments are composed in peace of the regimental staff, 4 batteries (numbered from 1 to 4), the ammunition park

[1] These were the numbers previously to the new organization of the field artillery, which was only carried out after the close of 1893.

cadre, and the ersatz depôt cadre. The 1st and 2nd regiments, the 4th to the 7th, the 10th and the 11th have each a horse artillery battery division with the number of the regiment, and each of the regiments with the exception of the 3rd, 4th, and 5th has a mountain battery with mountain equipment which has the number I.

The 42 divisional artillery regiments are constituted in peace like the corps regiments.

The mountain battery division, with 3 batteries with mixed equipment and the ersatz depôt cadre in peace, 6 mountain and 4 narrow-gauge 9-cm. batteries and the ersatz depôt, have remained unchanged.

Ammunition Parks and Columns.—In war, the ammunition park cadre of each corps artillery regiment forms the corps ammunition park, and a detachment for the reserve ammunition columns of the army park, the 8 regiments with horse artillery battery divisions form a cavalry ammunition column; they have the numbers of the corps regiment. The ersatz depôt cadre forms then the ersatz depôt of the regiment, the command of the ersatz depôt of the artillery brigade, and with regiments that have mountain batteries, each forms, as required, a second mountain battery having the number 2. The divisional park cadre of the divisional artillery regiment forms, in war alone, the divisional ammunition park with the number of the regiment and the ersatz depôt of the regiment.

It is deserving of notice that in order that on service the ammunition supply of the field batteries may be effected by simply changing the wagons, it has been ordered that the 9-cm. battery ammunition wagons of all ammunition columns are in future to have 6 horses instead of 4. The war establishment of the artillery ammunition columns and of the divisional and corps ammunition depôts will consequently each be increased by 4 drivers and 8 draught horses.

Supply.—Under the new regulations for the military supply establishments, the monarchy is divided into 50 supply districts.

Portugal.

The country is divided into 4 military divisions—Lisbon, Vizeu, Oporto, and Evora. The following table shows the composition and peace strength of the forces:—

Arm of the Service.	Officers.	Men.	Horses.
Superior staffs	378	—	293
Infantry—			
24 infantry regiments, 12 rifle regiments (each of 2 battalions), 36 battalion cadres	1,107	16,798	138
Cavalry—			
2 lancer regiments, 8 chasseur regiments (each of 3 squadrons), and 1 cadre squadron	275	3,952	2,289
Field artillery—			
3 regiments, each of 10 batteries (6 guns), and 2 cadre batteries (4 guns), 1 mountain artillery brigade of 2 batteries (8 guns), and 4 cadre batteries	154	1,860	1,084
Fortress artillery	76	1,599	6
Engineers—			
1 regiment of 2 battalions, 1 cadre battalion, 1 torpedo company	39	710	78
Total	2,029	24,919	3,888

Not including 28 medical officers and 13 chaplains attached to the superior staffs.

The peace strength was fixed for all services at 30,000 men. 13,917 recruits were enrolled, of whom 12,000 were allotted to the army proper, 417 to the navy, 500 to the municipal guard, and 1,000 for the customs guard.

On mobilization, the whole of the 108 infantry battalions are brought up to a strength of 16 officers and 888 men, each cavalry squadron to 3 officers and 79 men, each field battery to 8 officers and 169 men, the mountain batteries to 7 officers and 193 men, the fortress artillery companies to 4 officers and 86 men, and the engineer companies to 5 officers and 150 men. The field batteries have each 6 guns, the mountain batteries 8. The war strength, therefore, of the army should be, in round numbers, 4,000 officers and 150,000 men, with about 23,000 horses, mules, &c., and 264 guns. Looking, however, to the short period of time the new law has been in force, &c., probably the number of trained men available at the present moment is hardly 100,000.

Colonial Troops.—The colonial army consists of 1 regiment of infantry of 4 battalions, strength 50 officers and 1,143 men (exclusively Europeans), 8 rifle battalions for Africa, 2 rifle companies for Timor, &c. (for the most part natives), 488 officers, 7,797 men. The total strength of the colonial troops is consequently 538 officers and 8,940 men.

Training.—Financial difficulties prevent the assembly for manœuvres of any considerable body of troops; but arrangements were made for the exercising of small mixed bodies of troops at Lisbon, Oporto, and Tancos.

The Lisbon garrison formed 1 brigade, consisting of 2 regiments of infantry of 2 battalions, 2 squadrons of cavalry, 2 batteries of 6 guns,

2 subdivisions of sappers, and 1 telegraph section; also a marked brigade composed of 4 subdivisions of infantry (representing each a battalion), 2 subdivisions of cavalry (each representing a squadron), and 2 guns (each representing a battery).

The garrison of Oporto consisted of 1 infantry regiment of 2 battalions, 1 squadron, and 1 battery of 6 guns.

The mixed force at Tancos was formed specially for the purposes of these exercises, and consisted of 1 infantry regiment of 2 battalions, 1 squadron, 1 battery of 6 guns, and 1 pontoon company.

In order to improve the marching powers of the troops it has been ordered that, during peace, changes of station are to be always carried out by march route unless the movement is one of urgency, such as when troops are required to be sent to a place on account of disturbances, &c.

Russia.

The following tables give the composition and approximate strength in peace and war respectively of the army in Europe and in the Caucasus :—

Peace.

Units.	Men.	Horses.	Guns.	Wagons.
Infantry, calculated on an average strength of 500 men per battalion :—				
193 regiments of 4 battalions	362,840	4,825	—	16,598
68 rifle battalions	34,000	600	—	1,628
9 reserve brigades of 8 battalions	40,000	400	—	Not known.
15 reserve brigades of 4 battalions	32,000	300	—	—
Cavalry—				
545 squadrons and sotnias	90,000	87,750	—	4,095
Artillery—				
324 field batteries of from 4 to 8 guns...	70,000	20,000	1,944	—
44 horse artillery batteries of 6 guns ..	7,600	8,200	264	2,592
39 reserve batteries of 4 guns	7,800	2,166	156	484
Technical troops—				
31 battalions (besides parks)	20,000	465	—	1,500
Fortress troops—				
83 battalions	49,800	—	—	—
Total	714,040	124,706	2,364	Not known.

From what appears to be an authentic source, the whole strength of the Russian Army in Europe and the Caucasus is stated to amount to 30,574 officers and 751,000 men. In Asia to 75,000 men.

War.

Units.	Men.	Horses.	Guns.	Wagons.
Infantry—				
193 regiments of 4 battalions	772,000	40,000	—	17,000
68 rifle battalions	68,000	4,500	—	1,524
9 reserve divisions of 16 battalions	144,000	7,000	—	3,000
15 reserve brigades of 8 battalions	120,000	6,000	—	2,500
Cavalry—				
600 squadrons and sotnias	100,000	100,000	—	—
The 2nd and 3rd categories of the Cossacks	*75,000*	*75,000*	—	—
Artillery—				
300 field batteries of 8 guns	80,000	66,000	*2,640*	*7,590*
60 horse artillery batteries, including *Cossack batteries*	11,000	15,900	360	1,440
96 reserve batteries	20,000	19,200	768	2,198
Technical troops	*60,000*	—	—	—
Fortress troops	213,286	—	—	—
Total { From	1,663,286	Not accurately known.	3,768	Not accurately known.
Total { To	2,000,000			

By the expansion of the 68 brigades of rifles into divisions the number of combatants will be increased by over 100,000 men, and the number of combatants in the 15 reserve brigades will be doubled by their being made into divisions.

Formation of New Reserve Brigade Commands.—Previously the infantry reserve brigades were confined to those following immediately on the 41 field divisions numbered from 42 to 48, and to 2 brigades, Nos. 1 and 2, for the Caucasus, each of 4 regiments of 2 battalions, which in war were to form 4 battalions, so that each brigade produced an entire division. Besides these there were 52 (with the Guard 53) independent reserve battalions in Europe and 10 in the Caucasus, the combination of which in brigades was also contemplated. This important step has now been taken, though in a somewhat different manner to the formation of the older reserve brigades.

Staffs for 15 reserve infantry brigades have been formed, consisting of a major-general, an adjutant, a brigade-surgeon, and 5 clerks, which is the same as the establishment of the previously existing reserve brigades.

The whole of the reserve battalions in European Russia and in the Caucasus are allotted to these brigades, except 4 located in distant districts, 2 of which are in the Caucasus. These continue to be

under the local brigades. The battalions allotted to the new reserve brigades are, on the other hand, no longer under the local brigades, but are directly under the commander of the military district concerned. The newly-formed reserve brigades in European Russia are numbered from 49 to 61; in the Caucasus they form the 3rd and 4th Caucasian reserve infantry brigades. The number of the reserve battalions available for the purpose is 50 in Europe and 8 in the Caucasus; thus 13 brigades have each 4 battalions, but the remaining 2 have only 3 battalions.

The establishment of all the reserve battalions is being increased in view of their expansion into regiments; they already have 6 companies. Apparently, even in peace, the new brigades will not be left with only 4 battalions; the next step rather will be to form from each of the 4 battalions of some of the brigades, if not of all, a regiment of 2 battalions. By this means, the organization of these new brigades would be analogous to that of the old ones (Nos. 42 to 48) or of the rifle brigades, and their mobilization as divisions of 4 regiments, each of 4 battalions, would be further facilitated.

The European infantry may, therefore, now be reckoned, without counting rifle formations, &c., as 3 guards, 3 grenadier, and 57 line divisions, of which 20 are reserve. There remain for the Caucasus 1 grenadier and 8 line divisions, of which 4 are reserve. There are further, in European Russia, 2 (with the guard, which in war forms a separate regiment, 3) reserve battalions and 2 in the Caucasus, which, however, from the situation of their stations, those in Europe, for instance, at Archangel and Astrachan, can hardly be utilized to form field troops. Even if converted into regiments they would remain in their peace districts, as would also the 1 regiment and 29 battalions of fortress infantry. The greater portion of the new reserve brigades are located in the eastern part of the empire, viz., 8 brigades, and in the southern part 4.

Minor Changes in the Army of the Caucasus.—The 6 Kuban plastun foot battalions have, for the purpose of more effective control, been constituted in a brigade like the Caucasus rifles. Two of these battalions stationed on the frontier of Asia Minor are borne as detached.

The independent Kuban Cossack brigade, that consisted of two regiments, has been broken up. One of the regiments has been allotted to the Caucasian cavalry division, which had previously, besides its three dragoon regiments, only 2 sotnias of Cossacks. The division has, therefore, now 18 squadrons of dragoons and 6 sotnias of Cossacks. The second regiment of the brigade broken up has been placed directly under the Ataman of the Kuban levies. There are besides in the Caucasus 2 Cossack divisions, 1 independent Terek Cossack brigade and militias.

Transcaspian Troops.—Whereas hitherto the artillery of these troops consisted, apart from a Kuban Cossack battery, of two light batteries and a mountain battery of the 20th and 21st Artillery Brigades, these three batteries are now to return to the Caucasus, and three new independent batteries, numbered 1, 2, and 3, are to be

formed for Transcaspia. By this means the Transcaspian troops are rendered more independent of the Caucasus military district. They comprise 2 rifle brigades, 2 reserve battalions, 1 Cossack brigade, 1 Turcoman horse division (half a regiment), 3 batteries, 2 railway battalions, and 1 sapper company.

East Siberian Troops.—The line battalions have been increased by one, formed from local sources. There are, therefore, now 10 line and 10 rifle battalions, 1 artillery brigade, 1 Transbaikal, and 1 Amur mounted Cossack regiment, 1 Ussuri mounted half regiment, 2 Transbaikal, and ½ Amur foot battalion, and 2 Transbaikal horse artillery batteries.

Transport Arrangements in the Russian Army.—By an army order, No. 55, of the $\frac{6}{18}$ March, 1893, the establishments and lists of material for the train with the troops were definitely fixed. A prolonged course of investigations, commenced in 1879, after the Russo-Turkish campaigns of 1876–77 had brought to light the great shortcomings that existed in the train service, has thus been closed. As long ago as 1885, the work of the committees appointed resulted in new regulations being issued for the infantry regimental train. In 1890 the cavalry train was reorganized by the substitution of two-wheeled carts for the wagons that previously existed, and the mobility of the army materially increased. In 1891 the Cossack train was reduced and converted entirely into park transport. The later regulations cover the arrangements for the staffs of the superior commands, and fix the establishment and material authorized for the army corps, divisional, and brigade staffs.

Reorganization of the Frontier Guards.—This service is composed of both horse and foot, organized in brigades and detachments. The reorganization introduced had for its object to accentuate its connection with the army. The troops composing the formations are inspected annually by the commander of the military district in which they are located, in the same way as other troops. The Minister of Finance is their chief in peace-time, but on mobilization they form a part of the field army. In peace they consist of 29 brigades and 2 independent detachments.

1. East sea-coast, 4 brigades.
2. Prussian frontier, 10 brigades.
3. Austrian „ 6 „
4. Roumanian frontier, 2 brigades.
5. Southern „ 7 brigades, 2 independent detachments.

Each brigade consists of about 30 officers, 1,000 men, and 400 horses. The mounted portion is equipped like dragoons. On mobilization the 400 mounted men of each brigade form a frontier horse regiment of 4 sotnias, the 600 foot are formed in several companies. Thus on the Prussian frontier alone a new force of about 10 horse regiments and 40 companies of frontier troops have been called into existence. In combination with troops of the field army these formations will provide during the first days of mobilization

for the security of the frontier, a service for which they are eminently fitted.

They are officered from the army, colonels being in command of the brigades and field officers of the independent detachments. For the last two years portions of the force have taken part in the army manœuvres, and drill and rifle practice grounds have been provided for the men.

Formation of Siege Artillery Battalions.—In 1892 the first siege artillery battalion was formed at Kieff. The formation of two more was ordered to be commenced in January, 1893, opposite the East Prussian frontier, at Dünaberg and Brest-Litovsk. Each was to consist provisionally of two companies only.

Recruiting.—Hitherto under the provisions fixed in 1874 those young men who had on the $\frac{1}{13}$ January of the year concerned attained to 20 years of age, were chosen by lot for service during the period between the $\frac{1}{13}$ November and the $\frac{1}{25}$ December (in Siberia between the $\frac{15}{27}$ October and the $\frac{1}{13}$ January). Those taken were sworn in, and had to join shortly after; but their services did not begin to reckon until the $\frac{1}{13}$ January. By the new instructions of January, 1893, the drawing and enrolment take place between the $\frac{15}{27}$ October and the $\frac{15}{27}$ November, almost a month earlier, for those liable to service who by the $\frac{1}{13}$ October have reached the age of 21. The annual class called up are therefore older than formerly, which is of importance.

The regulations for recruiting in the Caucasus, which have been in force since 1886, have been somewhat modified. The "right" has been accorded to the Mohammedan Ossetines to give personal service as well as their Christian fellow countrymen, this service to be with the Terek Cossack regiments. The term of service is the same as for all others liable to serve in Transcaucasia, viz., 3 years with the colours and 15 years in the Reserve. The Russians and other not indigenous inhabitants of Transcaucasia are to be called up for service in the same proportion as the native population, and the resultant contingent is included in the total number of recruits necessary for the supply of the army and navy. The recruits taken are, however, enrolled only with the troops of the military district of the Caucasus.

The recruits belonging to the indigenous population in the Terek and Kuban territories, as well as those of Transcaucasia, are distributed as directed by the War Ministry amongst the troops stationed in the Caucasus. Objection is still taken to utilizing other branches of the Mohammedan, and in some degree of the Christian mountaineers for service in the regular army, for they are not trusted.

Difficulties in regard to Non-commissioned Officers.—The necessity for the creation of an efficient body of non-commissioned officers, of which those occupying the superior positions are re-engaged, has become more and more felt since the introduction of the new arm, and the difficulties of training and leading that are associated with it. To this must be added the short service (in the infantry 4 years), as making more difficult the formation of good non-commissioned

officers. Most of them now have not served this four years, and come from the so-called school commands, from which after nine months' training, those found to be suitable join the company for six months. The theoretical and practical knowledge gained by them at the schools are not sufficient to fit them for the performance of their duties as non-commissioned officers; and yet in the main these materials, which are discharged after 1½ years' service, have to suffice.

In order to get suitable men to re-engage many inducements were offered to them in 1888 and 1890, both in the shape of money awards and special privileges. Notwithstanding, however, these advantages, the experience of the last few years has shown that the inclination to re-engage is still small. The better men, who have some education and can work at a trade, find it repays them better to return to civil life than to continue serving. The remedy would appear to lie in the guarantee of civil State employment; but the posts at present retained for non-commissioned officers are altogether insufficient to have any material influence. In the meantime the situation is a serious one, the more so that in war each company apparently is to have no more than two officers, and the senior non-commissioned officers will have to occupy the vacant posts.

Mobilization.—New regulations were issued regarding the calling up with the Reserve of the active army and the opoltschenie of the officers, non-commissioned officers, and men of those categories, who in peace are in civil employ (including teachers). Their issue was necessitated by the former regulations having afforded such scope for exemption that difficulties arose in filling the post of officer, non-commissioned officer, and military official in the enormous reserve and opoltschenie formations contemplated. By the new regulations the officials of the four oldest classes are alone unconditionally freed from service, and the conditions regarding those of the remaining classes have been made more stringent. Those to be exempted are distinctly specified, according to the different departments of State, and only those are to be excused who cannot be dispensed with or replaced without detriment to the public service. The obligation to serve in case of war has been especially accentuated for those persons who have already received a military training, and are fitted to occupy the posts of officer or military official. Greater consideration can be shown in the case of the men, for amongst them there is no lack of trained soldiers.

Training.—The summer training adopted in Russia is in the form of local camps of exercise, of which there were 77 formed in 1893. The proportion of the troops that attended these was 71 per cent., which was 11 per cent. more than in the previous year, and in 27 districts there were movable manœuvres of from 8 to 14 days' duration. Of the infantry, 74 per cent. were exercised in division or brigade, only 26 per cent. in separate regiments.

Of the Reserve and fortress troops the whole of those in the military districts of Wilna, Warsaw, and Kieff took part in the general exercises, and 52 per cent. on an average in other districts.

The training of officers and men of the Reserve and of the ratniki of the opoltschenie took place as usual. Those called up are the men in the first category for the defence of the Empire (four annual classes), and they have two periods of training, each of three weeks' duration, at the headquarters of the district. The men of the opoltschenie are not provided with any uniform. The training afforded does not appear to be of a very practical nature or calculated to prepare the men for their duties in time of war.

Of the cavalry, 95 per cent. participated in the special concentration of the arm which took place at 19 different points. In the western military districts the whole of the cavalry took part in still larger concentrations (one and several divisions concurrently), in other districts 47 per cent. The opportunity of manœuvring with the other arms was given to 90·3 per cent. of the entire cavalry, including Cossacks of the 1st category.

The first training period for the artillery is very short, not quite four weeks, for most of the batteries, partly in the neighbourhood of the garrisons, partly in camps.

Gunnery practice occupied 8 weeks in 70 per cent. of the batteries, 6 weeks in 26·3 per cent., 4 weeks in 4 per cent. of them.

So-called great manœuvres were held only in the St. Petersburg, Moscow, and Warsaw districts.

The practice of field firing with forces of all arms, generally at war strength, was prosecuted with much energy, partly in winter.

The exercises of cavalry in swimming rivers were continued, and new means of carrying over the equipment are being continually tried. In the Warsaw district, for instance, boats and rafts made by the men themselves were employed. The materials for the construction of the rafts, viz., beams and planks, were carried with the troops and could be put together in 10 minutes. Each raft carried 40 saddles with arms and equipment and 4 men to manage it. The boats carried with the regiments were of waterproof sail-cloth.

The horses and men swam the rivers in different ways:—1. All either sat their horses or held on by the mane or tail; 2. A few horses were taken over after the boat, the rest followed in a herd; the men crossed, some in the boats and some swimming; 3. The horses swam, some with their riders and some alone.

Musketry Regulations for the New Rifle.—The following are the more noticeable alterations made in the regulations previously in force:—

1st. The limits of range at which firing is to take place have been extended, and they are fixed for individual practice of infantry and cavalry at 1,000 paces, for collective firing of infantry at 2,500 paces, and of cavalry at 2,400 paces.

2nd. The practices with small targets are increased, and they are placed at rather further distances.

3rd. The marking of the hits after every shot only takes place at the first two practices at 200 paces, in the subsequent practices after every five rounds.

4th. Practice ammunition is increased from 130 to 150 rounds.

5th. Individual practices take place at 800 and at 1,000 paces. Cavalry have mounted individual practice at the halt.

6th. Every man is required to judge distances up to 1,000 paces.

SWEDEN.

The army is constituted in peace in 6 army divisions, consisting of from 3 to 6 regiments of infantry of 2 battalions, 1 regiment of cavalry of 5 squadrons, 1 regiment of field artillery of 6 batteries.

To the 1st division, the headquarters of which are at Helsingborg, has, in addition, 3 independent battalions, 2 regiments of cavalry, 2 horse artillery batteries, and 1 battalion of train of 2 companies.

The 3rd division at Sköfde has 1 extra independent battalion, 1 battalion of foot artillery of 2 companies, 1 battalion of engineers of 4 companies, and 1 battalion of train of 2 companies.

The 4th division at Stockholm has 1 battalion of foot artillery of 4 companies, 1 battalion of engineers of 5 companies, and 1 battalion of train of 2 companies.

The 6th division (Oestersund) has a battalion of train of 2 companies.

The forces in Gotland are not included in these divisions; they consist of 1 regiment of 2 battalions, 1 division of field artillery of 2 batteries, and 1 company of foot artillery.

In war each army division furnishes 2 brigades (the 3rd, 3) of 12 battalions (the 3rd, 19), 1 regiment of cavalry of 4 squadrons, 1 regiment of field artillery of 2 divisions, 6 batteries, 1 company of engineers, and 1 battalion of train. The 3rd and 4th divisions have each 1 battalion of foot artillery, the former of 2 companies, the latter of 4.

A cavalry division is formed of 2 regiments, 16 squadrons, and 1 division of 2 batteries of horse artillery.

The forces in Gotland are, in war:—1 regiment of 3 battalions, 1 division of 2 batteries of field artillery, and 1 company of foot artillery.

Depôts are formed in each of the 6 division districts of 4 battalions (in the 3rd, 6), 1 squadron cavalry (in the 1st, 5), and 1 to 2 field batteries. There are, in addition, in the 1st division district, 1 horse artillery battery and 1 company train; in the 3rd and 4th division districts 1 company foot artillery, 1 company of engineers, and 1 company of train; and in the 6th district 1 company of train.

Strength.—In peace:—1,905 officers, 36,278 other ranks, and 6,756 horses of all arms and branches of the service.

In war, the strength is 2,348 officers and 49,741 other ranks. Taking those liable to service in the landstürm by yearly classes, the 1st levy, including the eight years from 1886 to 1893, may be estimated at about 180,000 men; the 2nd levy, comprising the classes from 1882 to 1885, both inclusive, at about half that number, or 90,000 men, the oldest of whom would be 32 years of age.

Train.—The transport of ammunition and provisions, both with the several units and with each army division, is provided for in detail.

With the troops each infantry battalion has 4 small-arm ammunition carts, 1 medical wagon, 4 provision and 5 baggage wagons; a squadron has 2 provision wagons and 1 baggage wagon; a field battery has 8 ammunition wagons, 2 provision and 5 baggage wagons. To the army division train belong the following in each division :—

Staff of the army division train with 4 wagons.
Staff of the ammunition columns with 3 wagons.
2 artillery ammunition columns (each with 19 ammunition wagons, 3 reserve limbers, 1 field forge wagon, and 2 baggage wagons).
2 infantry ammunition columns (each with 17 ammunition wagons, 1 field forge wagon, 2 baggage wagons, and 1 tool wagon).
4 supply columns (each with 1 field forge wagon, 1 baggage wagon, and 60 provision wagons).
4 forage columns (each with 1 field forge wagon, 1 baggage wagon, and 76 forage wagons).
1 cattle column with 1 wagon.
4 field hospitals (each with 200 beds, 2 medical wagons, 2 baggage wagons, and 8 transport wagons).
1 horse depôt, 80 horses, 2 wagons.
1 field bridging train with 24 bridge wagons, 4 tool and 4 forage wagons.

The train allotted to units is subdivided into fighting train and baggage train. To the former belong ammunition, medical, and tool wagons, to the latter all other vehicles belonging directly to the troops.

In marches under service conditions the vehicles of the fighting train, together with reserve horses, remain with the troops; each infantry battalion is followed immediately by its medical wagon, and each regiment by its ammunition wagons. With the artillery the 1st line (4 ammunition and 4 baggage wagons per battery) follow immediately after the guns; the 2nd line (4 ammunition wagons and 1 baggage wagon per battery) in rear of the marching column. The engineer field company is followed by the tool wagons, eventually, also, by the field bridging train, and the sanitary company by all its wagons. The baggage train is formed in one column in corresponding order to that of the troops, and follows them at a distance of from 2 to 3 kilometres.

In the event of there being a probability of a hostile collision in the course of the day, the army division train is divided into two echelons. The first echelon moves at about 5 kilometres from the rear of the baggage train, and consists of 1 artillery and 1 infantry ammunition column, 1 to 2 field hospitals, 1 to 2 provision and 1 to 2 forage columns. Upon an engagement occurring, the ammunition columns and field hospitals of the 1st echelon are moved up in part or entirely to the troops.

The remaining columns of the army division train form the second echelon and follow the first at a distance of about 2 or 3 kilometres.

Servia.

The peace establishment of the Regular army (not including superior officers, commanders, staffs, medical officers, veterinary surgeons, military officials, and artificers) during 1893 was 580 officers, 12,112 men, 2,773 horses, and 206 guns (including field, mountain, and fortress artillery). Besides these, about 6,400 recruits could be called up for a period of five months, and about 1,700 for one month. The whole establishment for the year was 15,002 men.

On mobilization each of the five territorial divisions of the active army is completed as follows:—

Infantry:—4 regiments of 4 battalions.....	16,224	all ranks.
Cavalry:—1 division of 2 squadrons	405	,,
Artillery:—1 regiment of 2 divisions of 3 batteries (6 guns).....	1,635	,,
Engineers:—		
1 company	515	,,
½ bridging equipage		
1 subdivision telegraphs		
1 intrenching-tool column		
Sanitary Service:—		
1 company	582	,,
1 sanitary column		
1 etappen field hospital.....		
1 sick horse depôt.....		
Artillery Establishment:—		
1 artillery ammunition column of 2 sections	473	,,
1 infantry ammunition column of 2 sections		
1 movable artillery workshop		
Supply and Administrative Formations:—		
1 provision column	1,281	,,
1 bakery company.....		
1 butchery company.....		
1 artificer company		
1 slaughter cattle depôt.....		
1 field post		
Strength of each division....	21,115	,,
For 5 divisions.....	105,575	,,

Outside, and in addition to the formations included in the division organization, there are the following:—

1 cavalry brigade of 3 regiments of 4 squadrons, 1 horse artillery battery : 1 ammunition column	2,684
Royal body-guard : 2 squadrons	300
Mountain artillery : 1 regiment of 10 batteries of 4 guns, 1 ammunition column	2,307
Fortress artillery : 1 regiment, 1 siege park	2,300
Arsenal artillery : 1 company	234
Reserve ammunition column : 5 sections	2,301
Pontoon troops : 1 battalion of 5 companies	1,095
Railway troops : 1 battalion of 5 companies	477
Miners : 1 company	234
Telegraphs : 2 divisions	264
2 bridging equipages	637
Special establishments	2,232
Together	15,065

There are, further, the ersatz and depôt troops, viz. :—

Infantry : 20 battalions of 4 companies	23,520
Cavalry : 5 squadrons	905
Artillery : 5 field batteries of 8 guns	1,890
„ 1 mountain battery of 6 guns	273
„ 1 subdivision of horse artillery	49
Engineers : 5 subdivisions	350
„ 5 subdivisions pontoon troops	395
Together	27,382

Summary :—5 divisions	105,575
Outside the divisional organization	15,065
Depôt and ersatz troops	27,382
Total strength of the regular army	148,022

Besides these troops composed of the regular army are the national levies of the 1st and 2nd Bans. The formations into which these are organized follow generally on the lines of the regular army. Thus, 5 divisions are formed from men of the 1st Ban that differ little either in composition or in strength from the army divisions; the formations outside the divisional organization are, however, limited to a few artillery and engineer formations. The depôt and Ersatz troops differ little in strength from those of the regular army.

The following is a summary of the strength of the 1st Ban formations :—

5 divisions	97,585
Outside the divisional organization	2,031
Depôt and ersatz troops	25,900
Total strength of 1st Ban levies	125,516

The levies of the 2nd Ban are applied to the formation of 5 divisions on a reduced strength, viz., each of 3 regiments of 4 battalions, 1 squadron, 1 company of artillery, and a sanitary company.

Together, per division	12,757
And for the 5 divisions.....	63,785

The total contemplated war strength, therefore, is the following:—

Regular army	148,022
1st Ban, popular levies.....	125,516
2nd „ „ „	63,785
Total.....	337,323

But there are wanting to complete some 18,000 of the regular army and about 10,000 of the 1st Ban; on the other hand, there is a surplus of about 36,000 of the 2nd Ban. A more serious difficulty is the want of officers; only by reducing the numbers with inferior units from 4 or 5 to 2 or 3 could the number of active and reserve officers suffice for the requirements of the regular army alone. There would, if this reduction were made, be about 170 officers still available for other formations, and these would, with about 130 officers on pension, give in all about 300 officers only for employment in connection with the territorial commands and popular levies. It is evident, therefore, that the mobilization and employment of the entire force the completion of which is contemplated in the scheme could not possibly be effected. The probability is, indeed, that, with the resources at present available, the completion of a force of 170,000 men is as much as could be counted on, or about a half of the force it is hoped some day to attain to, and this result would be dependent on financial considerations.

Organization: Changes in the Fundamental Military Law.—By a Ukase of the 2nd August, 1893, the permanent cadres of the regular army were fixed in the following manner:—

Infantry:—5 regiments of 4 battalions, of which 1 guard.

Cavalry:—1 guard regiment of 2 squadrons, and
1 cavalry brigade of 3 regiments of 4 squadrons.

Artillery:—5 regiments of field artillery of 3 divisions of 3 batteries.
1 regiment of mountain artillery of 5 batteries.
1 horse artillery battery.
1 fortress artillery regiment of 2 battalions, and
1 company of arsenal artillery.

Engineers:—2 battalions, one of 5 companies, the other of 3 companies of special troops.
½ battalion pontoon troops.

Special troops:—5 sanitary companies, 5 train squadrons, 5 bakery and 5 butchery sections.

The cadres of the 1st Ban of the popular levies are in peace to consist of a number of officers and non-commissioned officers, but this arrangement has not, as yet, been given effect to.

The effect of the change in the cavalry has been to augment each of the 3 regiments by a fourth squadron, and to add to it a second squadron of body-guard, to be amalgamated with the one previously existing into a body-guard regiment.

The field artillery receives an addition of 15 batteries, for a third division of 3 batteries is added to each of the 5 regiments. The whole of the batteries will have in peace 4 horsed guns, in war 6. The fortress artillery is doubled by the addition of a second battalion to the one previously existing, and the two battalions are to be formed into one regiment.

Remounts.—The difficulties in regard to the provision of a sufficient number of horses is one of the weakest points in the Servian scheme of mobilization. The requirements for the whole army on a war footing are estimated at 45,000 horses, whereas in peace barely 3,500 efficient horses are available. Of the balance of 41,500, not more than 10 to 20 per cent. are available in the country itself.

In these calculations the 22,000 oxen for the transport in the regular army and 1st Ban troops are left out of consideration. No decision has as yet been taken as to arming the troops with a magazine rifle, and, looking to the financial condition of the country, an early rearmament of the troops does not seem probable.

Infantry Tactics.

There are at the present time certain principles that have been accepted in every army, and it is with the development and application of these tactical principles that we are chiefly concerned. For instance, all are agreed that, in spite of improved arms, the offensive continues to be the most effective form of fighting. If reference be made to the regulations in force, it will be found that, whether they be German or Russian, Austrian or French, Italian or Belgian, in all the attack is advocated, as well as the development of the offensive spirit. The tactical literature of these countries offers the same picture. The adoption of the attack, indeed, by the infantry is claimed by most of the armies of the countries named as a speciality, which has always been peculiar to it.

The same is the case with the recognition of the great importance of the field artillery to the issue of the infantry fight. In all armies the field artillery has been brought up to the same standard in regard to number of guns, material, and organization, so that a superiority in artillery, such as favoured the Germans in the above respect in the Franco-Prussian War, would appear to be excluded from future wars. In any case, the infantry must not count on finding its way smoothed tactically, even in an approximate degree, in the way it frequently was in the war of 1870–71 by a preponderating artillery fire.

On the one hand, the recognition of the powerful influence of the co-operation of the artillery in the infantry fight has led to the artil-

lery being no longer regarded as an auxiliary arm during the chief stages of the battle, but as an equivalent factor. On the other hand, the infantry have recognised that, as a result of the general increase in effective power of the artillery, the so-called artillery duel will frequently not lead to any distinct suppression of either side, and the infantry will then have to bear the burden of the fight not only under the infantry fire of the enemy, but also under his artillery fire.

The conviction has become not less general that, without prejudice to the moral superiority of the attack, this, if undertaken against an opponent of equal value, will have a prospect of success only when a superiority of fire has first been secured.

This point is dwelt on in all regulations and in all tactical discussions. Whether, while fighting to secure this superiority of fire, one's own artillery will always be able to play a great *rôle*, must, from what has been said above, be a matter of doubt.

It is quite immaterial whether the superiority of fire be achieved by purely mechanical means, that is, by better shooting, or by a superior number of rifles in action, or by fire brought to bear on the enemy's flank or rear. It is just in this that tactical skill consists: so to bring up and place the troops as to produce situations that will facilitate the enemy's overthrow. Superiority of fire can only be obtained, directly or indirectly, by some tactical pre-eminence. This may be of a moral kind, such as when one of the opponents has more courageous, more highly disciplined, and better trained troops than those opposed to them. It can be found in more skilful tactical leading, that knows how to concentrate superior numbers at the decisive point. Lastly, it may be produced by a better strategic leading, that understands how to bring superior against inferior numbers.

But this tactical pre-eminence, as one of the most indispensable factors of success, will, in the future, be undoubtedly harder to achieve than it was in the case of the victors in 1866 and 1870–71. In 1866, amongst other points, there were the superiority of the infantry arm, the more skilful strategical leading, and more appropriate infantry tactics. In the year 1870–71, however, the tactics of the German infantry as such contributed but little to their tactical pre-eminence. The German infantry tactics were neither in their nature nor in their formations much superior to those of the French; but this superiority found its main support in the spirit that dictated always an obstinate pressing forward.

The development of infantry tactics from 1888 to 1893 has undoubtedly done more for the proper appreciation of their nature than in the period from 1870 to 1888. This development has benefited tactical formations, and no doubt now exists that the swarm is the only formation in which infantry can fight.

Infantry Tactics in the several Armies.

Germany.—The individual training of the infantry soldier continues to serve as the foundation of the tactical training, and if here and

there the objection is raised that this individual training places too great value on drill and parade, it may be answered that attention must be paid even to this purely mechanical part of the instruction, as a means to the attainment of discipline and military habitude.

On the other hand, a certain reaction is making itself felt in the German Army against too great scope being given to the tactical freedom of subordinate leaders. This tactical independence of the leaders of all grades has been specially developed in Germany, and credit must be given for this without necessarily agreeing with all the consequences of this development. In Prussia, and later in Germany, value was placed upon basing the exercises of the troops, as far as possible, on service conditions, and by this means improving the tactical *coup d'œil* of leaders, and their capacity for making decisions. This endeavour led, however, finally to the preference being given to minor tactics, to the so-called "detachment warfare," to the detriment of the tactical requirements of the battle, which differ in many particulars from those of detachment warfare. As, however, in war it is the pitched battles that decide victory or defeat, there is some danger in resigning oneself in peace to tactical usages and aspects which are not always in accord with the requirements of battle tactics.

By thus favouring detachment warfare for the purposes of tactical instruction, conceptions in regard to the extent of front and fighting area are easily dislocated, and tactical situations consequently produced which endanger the unity of tactical action. It is only natural that it should be in the German Army itself, in which tactical freedom of action has been longest inherent, that objection should first have been raised against the excessive application of the principle of tactical independence of the leaders.

It was noticeable, in the Autumn Manœuvres of 1893, that the tactical habitudes of detachment warfare just referred to frequently manifested themselves where they might easily be detrimental, that is, in the engagement of large bodies of troops. This was evidenced by the selection of fronts which were not always in proper proportion to the number of troops available, so that infantry regiments occupied an extent suited to a division; there was also too great an economy of forces, not always in accord with the tactical requirements of the present. Broad frontage is required for the infantry engagement, for by this means alone is it possible to have from the commencement an equal or greater number of rifles in action than the enemy; otherwise the endeavour to obtain the superiority of fire must remain a theoretical idea. Having regard to this tactical fact, the principle of fighting in deep formations, which is specially emphasized in the German regulations, must have its appropriate limits.

France.—Notwithstanding that the French Infantry Drill Regulations appeared a year later than the German, many in France are of the opinion that the latter takes far more account of the tactical requirements of the present than the French regulations. This was

shown in 1893, not only in the literature, but also in the scientific conferences, which have in France a great development and a certain authority. The French Drill Book, more than any other in force, the new English Infantry drill comes next, contains still certain sympathies with linear tactics. According to German conceptions, the so-called battalion school is still very complicated. The French infantry practises on the ground forms and formations which can hardly be called suited to service conditions. There is also a so-called normal attack in a fixed formation. The more or less official representatives of the regulations do not admit this, for they point out that the tactical instructions afford scope in every direction, and always emphasize the independence of the leader, which in itself excludes definite formations. On the other hand, in practice the endeavour undoubtedly prevails to follow the precise directions of the regulations.

The opposition to the tactical system of "petits paquets," which provided for small supports, large supports, &c., behind the skirmishing line, has been general. Both theorists and many of the practical soldiers on the other side of the Vosges wish to see the system done away with altogether, and replaced by arrangements that will admit of the fight being commenced with a sufficiently developed front.

This must receive complete approval. Apart from the fact that with the existing system it will never be possible to wrest the superiority of fire from a well led opponent, who from the commencement has deployed a strong firing line, it is even doubtful whether the supports, echelons, &c., which should reinforce the advanced fighting line will really be able to do so. They serve not only as targets, which become smaller and smaller, but it may be doubted whether it will be possible to bring these supports forward into the fighting line at all during the fire fight without enormous losses.

Again, the objection, not seldom heard, that the deployment of strong firing lines from the first entails too heavy losses, is not sound, for official experiments have proved that the percentage of losses in thick firing lines is no greater than in thin ones. This seems to settle, once and for all, the tactical controversy, by showing that in all circumstances a thick firing line is tactically of greater advantage than a thin one, because the former brings more rifles into action, and by this means is able earlier to gain the superiority of fire, the ultimate object of all infantry tactics.

Objections have also been raised in some quarters against strong advanced guards, because they favour the splitting up of the forces and make the united action of the troops more difficult. Also the deployment from deep formations by pushing up the successive infantry fractions has been found fault with, and in place of it is advocated the simultaneous advance and deployment of several columns, which would enter into the fight of the advanced line together. In connection with this tactical tendency, which aims at simultaneous effect and at a great effect at the first stage of the engagement, is the desire to embody the principle in the order of

march of the troops. General Lewal is the exponent of this principle, and his views on the subject have been set forth in the "Journal des Sciences Militaires, 1893," under the title of "Stratégie de Marche." In place of the helpless division and army corps columns now generally employed, he would substitute brigade columns with artillery attached to them, which would march on parallel roads, or even on so-called column roads specially constructed. The idea is not new; Napoleon approved of it, and instances of its application are to be found in the war of 1870–71.

General v. Scherff has recently expressed the same opinion, but exclusively for employment during the advance to actual combat, and both he and General Lewal are agreed in desiring that at our peace manœuvres more attention should be paid to these movements, both on the march and in manœuvre.

Great tactical advantage is expected from the so-called "sections franches" of infantry battalions. They are intended to serve as battle patrols, in the widest sense of the word.

Field Artillery Tactics.

The chief question, it might almost be said the only one, with which artillery literature was occupied in 1893 was that of the field gun of the future. Should it be a gun with the greatest possible fire effect and of sufficient mobility—that is, of from 1,850 to 1,900 kilos.—or should the greater effect of the single round be abandoned, the greatest value attributed to rapidity of fire, and a gun be adopted with a materially lighter projectile and moderate initial velocity that would have little or, if possible, no recoil? Should the principle be retained of one uniform calibre, or should two calibres be adopted—the one heavy, having the propensities described above, and one light of the quick-firing type referred to? Should we be satisfied in future with the effect of high-explosive shell from field guns against objects behind light earthworks, and only resort to horsed batteries of foot artillery in special cases, when the defensive position to be attacked has been prepared long beforehand; or should light calibre howitzers be adopted as an integral part of the field artillery? If the answer be in the affirmative, what is the proper place for these guns in the *ordre de bataille?*

The field artillery has but one task to fulfil in battle, and that is to support the infantry, whether in the attack or defence. The first act is the engagement with the hostile artillery, the issue of which is of the greatest importance to the result of the battle. If the attacking artillery succeeds in overpowering that of the defence, it remains master of the field, and can carry out undisturbed its second task, which is, the preparation of the infantry attack by bombarding the point selected for attack. But if the attack should not succeed in driving off the hostile artillery, if the balance even should incline somewhat in favour of the defender, the attack need not on this account be absolutely given up; but the prospects of success will undoubtedly be much less: in any case, it will be very costly. But

it may also happen that the force that was the stronger at the commencement of the fight finds itself obliged to abstain altogether from attack, and may even be glad if it is able to repulse its opponent's attack. It is therefore a desideratum to have if possible a gun superior to the enemy's artillery, that is, one which allows of rapid fire which, though not perhaps strictly accurate, will still produce sufficient effect. For this purpose, what is wanted is a gun to fire shrapnel with a large number of bullets and having a flat trajectory. Under similar conditions a heavy shrapnel is always superior to one of less weight, and more so the greater the range and the less accurate the fire. By this is meant not the absolute superiority, which stands to reason, but the relative; that is, in the firing of equal weights of ammunition the heavy projectile will always produce a greater effect than the light. The light gun can undoubtedly make up for the less effect of the single shot by greater rapidity, especially at short ranges, but hardly at distances at which the artillery action will presumedly be fought.

A material increase in rapidity of fire is only possible by getting rid altogether of the recoil. Endeavours have been made to do this in various ways, but, short of injuriously reducing the initial velocity, no satisfactory solution has been found. In the opinion of the writer of this report on field artillery, the gun of the future should be one of about 8 cm. calibre, firing a projectile of from 7 to 7·5 kg., the velocity of which would be as high as possible without necessitating an increase in the weight of the present gun-carriage (500 to 550 m.). This gun would be furnished with every appliance that would contribute towards increasing the rapidity of fire without subordinating the effect of the single shot. Therefore no reduction in the weight of projectile, no spur or carriage in two portions. We are convinced that with a gun of this nature from 3 to 4 well-aimed shots could be fired in the minute, which, at ranges over 3,000 m., would undoubtedly effect more than 8 or 10 rounds which Longlois, the chief exponent of the quick-firing gun, would fire with his gun in the same time, for it is impossible that it could be properly laid.

Whether, besides this gun, it is necessary to have a lighter one for the horse artillery, depends on the demands to be made on that branch. The weight of the gun described above could, without difficulty, be brought within 1,850 to 1,900 kg., which is not too heavy for field artillery. If what is expected of the horse artillery is that it should support the cavalry in its service of exploration in front of the army, when it comes to be a matter of breaking down local resistance, such as opening a defile, fighting on foot, &c., this weight is quite possible. But if it be considered necessary to support the attack on hostile cavalry by horse artillery—looking to military history the case will hardly occur—then the weight must be reduced to 1,650 kg., perhaps still lower.

The introduction of field howitzers has lately been advocated from many sources and for many reasons as necessary. Some believe they cannot be dispensed with because the effect of high-explosive shell fired with a low trajectory against objects behind cover have not

always answered expectations, which have perhaps been fixed too high. Undoubtedly a well-placed high-explosive shell from a howitzer or mortar will have a greater effect than if fired from a field gun; further, the percentage of effective rounds will be greater; and, lastly, the large fragments of the heavier shells fired from the high-angle guns will pierce the light splinter-proof cover provided, which it is doubtful whether the splinters of the improved high-explosive shell will do.

On the other hand, such serious evils are associated with the introduction of a gun that is required only for special purposes, such as the howitzer, which could do little or nothing in the artillery combat, that only absolute necessity could justify it.

It has generally been maintained that in dealing with a stationary enemy under cover it is sufficient to support the infantry attack by driving the enemy from the parapet and thus forcing him to inaction. But this can be effected by shrapnel fire, perhaps by directing a sudden fire on the infantry trenches with a view to making the defenders believe that the assault is imminent, and so drawing them from their cover. By this means considerable losses will be inflicted, and the defenders' moral power will be perhaps more affected than by a long continued bombardment with high-explosive shells.

In our opinion, it will be for the superior commander to decide which course to adopt. In many ways, if not in most cases, howitzers will not produce a greater effect than the high-explosive shell of the field guns.

In those cases in which the enemy has had a long time for the preparation of his position, horsed batteries of foot artillery would be used, the guns of which are capable of penetrating strong cover, and which possess the means of observation even of exceptionally difficult objects.

It is contended, on the other hand—and the well-known Austrian, Count v. Wuich, is an adherent of this view—that the introduction of a field gun for high-angle fire is not only desirable for firing at sheltered objects, but that it is necessary in the final stages of the battle, when firing over one's own troops is unavoidable but too dangerous with guns having a low trajectory. Colonel v. Wuich is of opinion that on level ground it is possible now to fire over infantry at ranges of 1,500 m. and upwards, but that this distance must be increased if guns having a flatter trajectory be employed.

We should be reconciled with the introduction of a high-angle fire gun, as a necessary evil, in the case of the bombardment of covered objects being absolutely necessary, and if the effect of high-explosive shells from field guns be declared to be inadequate, even when fired with reduced charges.

As regards the place for this class of gun, if adopted in the *ordre de bataille*, it has been suggested that in every division of field artillery there should be one howitzer battery. But this would be a retrograde movement, for one of the greatest advances made in artillery tactics since the war of 1870–71 has been the constitution of the division as the tactical unit for field artillery; and, further, it is

evident that one howitzer battery per artillery division would be out of all proportion to the requirements of the case.

If it should be deemed indispensable to allot guns of this nature to every army corps, then the proper place for them would appear to be in a separate division of three batteries attached to the corps artillery.

NAVAL AND MILITARY NOTES.

NAVAL.

Home.—The following are the principal appointments which have been made: Captains, A. D. Acland to "Australia;" F. W. Fisher to "Orlando;" C. R. Arbuthnot to "Crescent;" H. Rose to "Indus." Commanders, A. M. Farquhar to "Buzzard," reappointed; C. Windham to "Fearless," reappointed; F. G. Stopford to "Tartar."

The new torpedo-gunboat "Harrier" has completed her steam trials satisfactorily. She went through her eight hours' natural draught trial on the 28th August; there was no difficulty in exceeding the 2,500 I.H.P. stipulated for in the conditions of contract. The speed results, for which the contractors do not hold themselves responsible, were agreeably surprising, for whereas the "Halcyon" and "Hazard," of the same type as the "Harrier," obtained on their natural draught trials speeds of 16·9 knots and 17·1 knots respectively, the "Harrier" made at least 18 knots. The estimated speed of these vessels at load draught, with clean bottoms and in smooth water, is 17 to 17·5 knots, so that the results on this occasion were especially gratifying. For eight hours' steaming the mean results were:—Steam in boilers, 150 lbs.; engines, 148 lbs.; vacuum, starboard, 26·9, port, 26·8 inches; revolutions, starboard, 229·5, port, 228·1; indicated horse-power, 2,696 (the guaranteed horse-power being 2,500); air pressure, 0·84 of an inch.

On the 11th of September the four hours' trial under forced draught was carried out equally successfully. There was no difficulty in attaining, and even exceeding, the contract force of 3,500 H.P., and as far as speed is concerned the vessel also proved herself a success. She ran easily 19 knots per hour, being 1·3 knots more per hour than was recorded of the "Halcyon," a sister ship engined by the same contractors. The mean results were:—Steam in boilers, 149 lbs.; in engines, 144 lbs.; vacuum, starboard, 27·6 in., port, 27·1 in.; revolutions, starboard, 255·1, port, 252·7; I.H.P., 3,592; air pressure, 1·77 in.; speed by log, 19 knots. The "Halcyon" is as soon as ready to proceed to Portsmouth from Plymouth, where she will be subjected to a series of progressive trials and special tests.

The new torpedo-boat destroyer "Lynx," built and engined by Messrs. Laird, of Birkenhead, has completed her trials successfully. She is a sister vessel to the "Ferret," also lately completed by the same makers; their engines, with slight modifications, are the same as those made by the same builders for H.M.S. "Rattlesnake" in 1886, and the Argentine boats "Espora" and "Rosales" in 1890. The boilers, however, are of the Normand water-tube type. The trials of the "Lynx" gave the following results: Speed on the measured mile, 27·15 knots; mean speed for three hours, 27·01 knots, the contract speed being 27 knots. The bunker capacity is 70 tons, and the engines are of the triple-compound type, with cylinders 19 in., 29 in., and 43 in. in diameter, with 18 in. stroke.

The trials of the new 2nd class cruiser "Flora" do not appear to have been so satisfactory as was reported at the time. A report was sent to Whitehall for the consideration of the Admiralty, and it is stated that their lordships are so displeased with the results recorded that they have directed the attention of the machinery contractors to the necessity of rendering the vessel more efficient.

During the steam trial considerable difficulty was experienced with the eccentrics and piston-rod guides, and the bearings heated to such an extent as to make it necessary to throw water on them to keep them cool. On the forced draught trial the back pressure on the low-pressure cylinder shown on the indicators was regarded as excessive. A high air pressure (rising to a maximum of 2½ in.) was found to be necessary to obtain 9,000 indicated horse power provided for in the conditions of contract. The results point to an unnecessarily large consumption of coal, which cannot be regarded as satisfactory, as the economical working of the machinery at all powers is of the greatest importance. The contractors, in reply, point out that they were not altogether responsible for these results, which were due in a great measure to the hurried manner in which the trials were carried out. They state also that the difficulty in question was due to the insufficient water supply for the ordinary water service, through scoops having been omitted on the inlets; but these have since been fitted, and no further difficulty should be experienced. Referring to the excessive back pressure on the low-pressure cylinder, and the high-air pressure necessary during the forced draught trial, the contractors say, "Knowing that the crew had to be withdrawn from the 'Flora' for the manœuvres three days after the natural draught trial, there was insufficient time to refill the boilers with fresh water after that trial, which we should have done had there been time. As a result of the condition of the water the boilers were priming almost continuously throughout the whole of the forced draught trial, which, we think, accounts in the main for the excess in the back pressure on the low-pressure cylinder, and the higher air pressure required in the stokehold. The latter was also considerably augmented by the coal being much dirtier than we anticipated, and we feel assured that under ordinary conditions, and with the coal usually supplied to Her Majesty's ships, the working of the machinery will be found perfectly satisfactory."

Great secrecy is being observed with regard to the pneumatic gun trials at Milford Haven. The authorities appear to believe that the new weapon is one of the most effective ever designed. The "Harpy," which is being used as a target ship in connection with the experiments, has been specially fitted for this service by the dockyard authorities at Devonport, and the cost of both material and labour will be defrayed by the War Office. In addition to being fitted with hawsers and slings to facilitate the work of raising her in the event of her sinking, 500 watertight casks have been stowed between decks to increase her buoyancy. Spars have also been fitted over her side, which, when rigged out, will be capable of suspending explosives 100 feet from the vessel. The Ordnance Committee, under whose direction the experiments are to be carried out, have already arranged a programme of trials for which the ammunition and stores to be supplied will include 16 15-in., 29 10-in., and 64 8-in. shells, filled and fitted with fuzes; six charges of wet gun-cotton, each 250 lb. in weight, with a 2-lb. primer of dry gun-cotton, and nearly 50 dummy shells.

Series 1 of the programme, which was commenced as soon as the "Harpy" had been moored off Dale Point, was the trial of projectiles of the pneumatic gun against the target ship. The vessel is moored in 60 ft. of water, and during the trials will have her boilers working at full pressure, this being arranged by the engine-room staff on board before leaving the ship. A number of 250-lb. charges (the bursting charge of the 10-in. projectile) will be exploded consecutively at a depth of 25 ft. The first charge was to be fired at a horizontal distance of 100 ft. from the ship's side, the second to be at 80 ft. distance, and the third to be at 60 ft., unless the results of previous rounds should indicate a variation from this arrangement to be advisable. Should the machinery and boilers be still serviceable, two or three additional charges will be exploded at closer ranges, to be decided according to the results of the previous charges. During these trials a naval engineer will inspect and report upon the condition of the steam pipes and boilers after each explosion, and an official from the Dockyard Constructive Department will perform a similar duty with reference to the hull, although it is not anticipated that the hull of the ship will be seriously damaged by the first series of experiments.

The keel-plate of the "Prince George," 1st class barbette battle-ship, was laid down at Portsmouth, on the 10th September. Owing to her great length, it was necessary to reduce the gradient of the blocks, partly to demolish the plate-bending factory, and to sink the roadway under her prow to facilitate the conveyance of material. Her stern also projects so far beyond the slip that it will only be possible to advance the lower work at low tide. The "Prince George" is a sister ship of the "Majestic," and consequently is of somewhat larger dimensions than those of the ships of the "Royal Sovereign" class. Her length will be 390 ft., her breadth 75 ft., and mean load draft 27½ ft., with a displacement of 14,900 tons, while the total weight of the protective material of the hull (including the protection of the auxiliary armament and protective deck) is to be greater than the corresponding weight in the "Royal Sovereign." The thickness of the side armour has been reduced from 18 in. of compound plating to 9 in. of Harveyized steel armour. The battle-ship will carry four 12-in. breechloaders, contained in two barbettes, and the mountings will be so arranged that the guns can be loaded in any position by manual power. But the main armament will be carried 4 ft. higher than the guns of the "Royal Sovereign," with increased freeboard in proportion. The secondary armament will consist of twelve 6-in. and 28 smaller quick-firing guns. Bilge keels, 200 ft. in length and 3 ft. in depth, will be fitted. The contract for the engines has been placed with Messrs. Humphrys, Tennant, and Co. They are to develop 12,000 horse-power under forced draught, and 10,000 with natural draught, and are estimated to give the ship a speed of 17¼ and 16½ knots.

According to the "Naval and Military Record," since the introduction of Harveyized armour for plating battle-ships and cruisers, the dockyard officials have been put to their wits' ends to devise some means for drilling the necessary holes for securing the plates in place. The drills now used become damaged in working the hard prepared plates; in fact, very little working of the Harveyized armour is sufficient to render the drills useless. It has now been suggested that the holes required in the plates should be fused by means of voltaic electricity, and the Admiralty so far favour this suggestion that they have given directions for the necessary plant to be supplied to each of the home dockyards. At Devonport, arrangements for fusing the holes are to be made at once, and the plant will consist of a set of 400 ampère electric light machinery (Willems-Siemens combination, last used in the ill-fated "Victoria," battle-ship, and transferred from her to Malta Dockyard before her last cruise), and one of the four boilers recently removed from the "Sharpshooter," gunboat.

A well-known name passes away from active service in the fleet; the "Himalaya," the oldest vessel on the effective list, has been paid off, and is to be sold out of the service, although it is stated that her hull now is as sound as when she was bought 30 years ago. She was built in 1853 by Messrs. Mare and Co., of Blackwall, for the P. and O. Steamship Company, but in July, 1854, the Admiralty, being anxious to secure a suitable vessel for the conveyance of troops to the Russian war, purchased her for £130,000. Since then she has been continuously employed as an Imperial troop-ship, her longest rest being in 1881, when she was supplied with new engines and boilers by Messrs. Maudslay, Sons, and Field, at a cost of 33,000*l.* Since her purchase money was paid (at which time she was completed for sea) she has cost in maintenance and repairs over 500,000*l.*

It is now reported that the "Assistance," whose hull is in very good condition, will not be put up for sale, but is to be attached as tender to the "Asia," the depôt ship for stokers at Portsmouth, which is at present very overcrowded; the engines and boilers of the ship are to be left in her, and kept ready for use, in case of her services being at any time required.

Another interesting Return has lately been presented to Parliament by the Admiralty, and, as it is short and useful for purposes of reference, we reproduce it

for the benefit of readers of the Journal, who may not have an opportunity of seeing the original. It is entitled:

"RETURN of Seagoing War Ships in Commission, in Reserve, and Building; and showing the Naval Expenditure, Revenue, Tonnage of Mercantile Marine, and Value of Seaborne Commerce of various Countries for the year 1893;"

"And, RETURN showing Naval Expenditure on Seagoing Force, the Value of Seaborne Commerce (exclusive of Interchange with the United Kingdom), and the Revenue of British Self-governing Colonies for the year 1893 (in continuation of Parliamentary Paper, No. 396, of Session 1890-91, and of No. 372, of Session 1893)."

(*See facing page.*)

The Lessons of the Engagement off the Yalu. (Reprinted by permission from "The Times.")—Sir,—There is—it may be freely admitted—no small presumption in asking you to find room for a letter on the engagement off the Yalu after the very able manner in which it has been dealt with by the writer of the article on "The War in the East" in "The Times" of this morning. An event like the recent engagement, however, is so rare, and the consideration of it is of such great importance to a naval people like ourselves, that you may be willing to admit to your columns another and rather more minute discussion of its details. Such a discussion has been made possible by the valuable telegram in "The Times" of yesterday from your Special Correspondent at Chefoo, to whom every student of naval warfare in this country ought to be grateful.

The composition of the contending fleets—as reported in the telegrams from both sides published during the last few days—is given in the following tables, which are taken from Lord Brassey's "Naval Annual" for the present year, except as regards the two Chinese gunboats. These are assumed to be of the "Epsilon" and "Zeta" type, and their tonnage and armament are taken from Brassey's "British Navy," vol. i, 1882. In the statement of the guns, light pieces, such as the 12-pr. of the gunboats and field and boat guns in other ships of both fleets, are omitted, for they were probably not used:—

RETURN of Seagoing War Ships in Commission, in Reserve, and Building; and sh
Countries for t

COUNTRIES.	SEAGOING WAR VESSELS.								
	IN COMMISSION.*				IN RESERVE.*				BUIL
	Battle-ships.	Coast-defence ships (armoured).	Cruisers (armoured and un-armoured).	Other ships not torpedo-boats.	Battle-ships.	Coast-defence ships (armoured).	Cruisers (armoured and un-armoured).	Other ships not torpedo-boats.	Battle-ships.
BRITISH EMPIRE.									
United Kingdom.....	24	4	63	78	15	12	53	46	7
India (*i*)	—	1	—	1	—	1	—	1	—
Self-governing Colonies (*k*).	—	—	4	2	—	1	2	4	—
Other Colonies.....	—	—	—	—	—	—	—	—	—
Total British Empire...	24	5	67	81	15	14	55	51	7
France.....	18	4	31	24	9	10	18	15	9
Russia.....	5	—	6	9	2	14	7	27	9
Germany	8	—	13	6	7	13	15	6	7
Italy	9	—	5	14	5	4	10	21	3
Spain	1	—	10	50	—	1	1	2	1
Austria-Hungary.....	1	—	5	5	7	—	5	15	—
Netherlands	1	7	4	41	1	10	5	23	—
Portugal.....	1	—	2	23	—	—	—	6	—
United States.....	—	—	13	11	—	15	11	7	6
China	2	1	12	48	—	—	—	19	—
Japan	1	—	17	10	—	—	4	—	—
Chile.....	1	2	4	4	—	—	2	2	—
Brazil.....	2	—	3	14	—	2	—	—	—
Argentine	3	2	2	9	—	—	1	4	—

* The first three columns in each division are based on Parliamentary Return No. 465 of 15th December,
the number of "other ships" to which a present fighting value may be assigned.

RETURN showing Naval Expenditure on Seagoing Force, the
Revenue of British Self-governin

COLONIES.		Naval expenditure on seagoing force.‡	
		£	
British North America.....	Canada	—	
	Newfoundland	—	
	Total..... £	—	
British South Africa.....	Cape Colony.....	—	
	Natal.....	—	
	Total..... £	—	
Australasia.....	New South Wales....	109,169 (*l*)	
	Victoria	84,025 (*l*)	18
	Queensland	25,269 (*l*)	18
	South Australia.....	22,996 (*l*)	18
	Western Australia....	1,722 (*l*)	
	New Zealand.....	20,489 (*l*)	18
	Tasmania	4,932 (*l*)	
	Total..... £	268,602 (*l*)	
	Grand Total..... £	268,602 (*l*)	

d showing the Naval Expenditure, Revenue, Tonnage of Mercantile Marine, and Value of Seaborne Commerce for the latest Year for which Information is available.

Building and Completing for Sea.*				Aggregate naval expenditure.	Aggregate revenue.	Aggregate tonnage, mercantile marine (vessels of 100 tons gross and upwards).	Value of seaborne commerce.	R
tle-ps.	Coast-defence ships (armoured).	Cruisers (armoured and un-armoured).	Other ships not torpedo-boats.					
7	—	15	51	£ 17,402,742 (*n*) (1892-93)	£ 90,395,377* (1892-93)	Tons. 11,563,997 (1893-94)	£ 681,826,448 (1893)	(*a*) Figures show tens exchange for 1891-92 w 1*s.* 4¾*d.*
–	—	—	—	295,153 (*o*) (*a*) (1892-93)	89,143,283* (*a*) (1891-92)	42,016 (net) † (1892)	103,263,941 (*a*) (*b*) (1891-92)	(*b*) Excluding trade w necessarily counting inte
–	—	—	—	268,602‡ (*l*) (1891-92)	43,037,178* (1891-92-93)	1,059,071 (net) † (1892)	88,542,868 (*b*) (1891-92)	(*c*) Total trade.
.	—	—	—	—	6,116,658* (1891-92)	113,585 (net) † (1892)	55,406,000 (*b*) (*k*) (1891-92)	
7	—	15	51	17,966,497	228,692,496	12,778,669	929,039,257	(*d*) Approximate only tion between seaborne a
9	—	16	4	10,901,858	134,560,000 (1891)	1,052,022 (1893-94)	271,972,000 (1892)	(*e*) Estimated normal
9	2	2	3	5,249,280	93,467,000* (1891)	492,202 (1893-94)	64,142,000 (1891)	(*f*) Does not include
7	—	1	1	3,696,149	62,661,000* (1890-91)	1,735,683 (1893-94)	211,402,000 (1890)	(*g*) Includes border t
3	—	8	2	3,834,816	70,319,000* (1891-92)	796,247 (1893-94)	46,293,000 (1891)	(*h*) Includes Her M of floating trade in Aust
	—	7	8	889,000	31,179,000 (1891-92)	564,404 (1893-94)	64,636,000 (1891)	(*i*) Includes Her Ma naval defence of India.
	3	2	—	1,039,806	97,981,000 (1891)	298,674 (1893-94)	22,850,000 (1890)	(*k*) There are no Ret tar. The trade of Ho than the United King £40,000,000.
	3	—	—	1,178,542	10,970,000 (1892)	442,071 (1893-94)	65,044,000 (1891)	
	—	—	—	590,000	10,513,000 (1892-93)	104,394 (1893-94)	14,186,000 (*d*) (1890)	(*l*) From the "Victo
	5	5	3	4,362,291	153,417,000* (1891-92)	1,005,950 (net) † (1890-91) (*f*)	373,256,000 (1890-91)	(*m*) All figures for t Colonies are from Boar
	—	—	1	?	18,413,000 (*e*)	48,129 (1893-94)	58,000,000 (*d*) (1891)	(*n*) Of this total, £1 ture; £2,065,900 was Defence Fund (outside ture under the Imperia
	—	—	1	2,267,811	16,455,000 (1891-92)	173,283 (1893-94)	23,742,000 (1891)	
	—	1	—	?	4,030,000 (1892)	108,626 (1893-94)	28,392,000 (*c*) (1890)	(*o*) Includes a con Majesty's ships in Ind still under considerati Her Majesty's ships ar of India. The amoun will in future be £59 Rx. 195,153 represents Marine.
	—	—	—	779,628	25,720,000 (1891)	196,981 (1893-94)	65,016,000 (*c*) (1890)	
	—	1	—	382,321	23,580,000 (1892)	54,454 (1893-94)	46,067,000 (1890)	

mber, 1893. The fourth column contains

From the "Statesman's Year Book." Those marked * from Board of Trade Returns.

From Lloyd's Universal Register. Those marked † from Board of Trade Returns.

From Board of Trade Returns. Figures for Brazil from the "Statesman's Year Book."

the Value of Seaborne Commerce (exclusive of Interchange with the United Kingdom), and the erning Colonies for the latest Year for which Information is available.

e	Year.	Value of sea-borne commerce, exclusive of inter-change with United Kingdom. (*m*)	Year.	Revenue. (*m*)	Year.
	—	£ 14,750,000 (*d*)	1891-92	£ 7,586,686	1891-92
	—	2,082,986	1891	392,586	1892
	—	16,832,986 (*b*)	—	7,979,142	—
	—	2,419,438	1892	4,495,344	1891-92
	—	1,290,783	1892	1,392,455	1891-92
	—	3,710,221 (*b*)	—	5,887,799	—
	1891	26,210,875 (*g*)	1892	10,501,104	1892
	1891-92	16,932,500	1892	6,963,292	1892-93
	1891-92	7,406,769 (*g*)	1892	3,445,943	1892-93
	1891-92	9,950,865 (*g*)	1892	2,538,995	1892
	1891	1,285,061	1892	543,888	1892
	1891-92	4,226,920	1892	4,389,251	1892
	1891	1,986,671	1892	787,764	1892
	—	67,999,661 (*b*)	—	29,170,237	—
	—	88,542,868 (*b*)	—	43,037,178	—

Remarks.

‡ The annual Australasian contribution of £126,000 for Her Majesty's vessels for the defence of floating trade in Australasian waters is included in these figures, the distribution being as follows:—

	£
New South Wales	37,656
Victoria	37,414
Queensland	13,260
South Australia	10,527
Western Australia	1,722
New Zealand	20,489
Tasmania	4,932
	£126,000

ssion, in Reserve, and Building; and showing the Naval Expenditure, Revenue, Tonn
Countries for the latest Year for which Information is availab

SEAGOING WAR VESSELS.									
In Reserve.*				Building and Completing for Sea.*				Aggregate naval expenditure.	Aggrega
ttle-ips.	Coast-defence ships (armoured).	Cruisers (armoured and un-armoured).	Other ships not torpedo-boats.	Battle-ships.	Coast-defence ships (armoured).	Cruisers (armoured and un-armoured).	Other ships not torpedo-boats.		
								£	
15	12	53	46	7	—	15	51	17,402,742 (*a*) (1892-93)	90,39 (189
—	1	—	1	—	—	—	—	295,153 (*o*) (*a*) (1892-93)	89,143 (189
—	1	2	4	—	—	—	—	268,602‡ (*l*) (1891-92)	43,037 (1891-
—	—	—	—	—	—	—	—	—	6,116 (189
15	14	55	51	7	—	15	51	17,966,497	228,692,
9	10	18	15	9	—	16	4	10,901,858	134,560, (18
2	14	7	27	9	2	2	3	5,249,280	93,467, (18
7	13	15	6	7	—	1	1	3,696,149	62,661, (1890
5	4	10	21	3	—	8	2	3,834,816	70,319, (1891
—	1	1	2	1	—	7	8	889,000	31,179, (1891
7	—	5	15	—	3	2	—	1,039,806	97,981, (18
1	10	5	23	—	3	—	—	1,178,542	10,970, (18
—	—	—	6	—	—	—	—	590,000	10,513, (1892-
—	15	11	7	6	5	5	3	4,362,291	153,417, (1891-
—	—	—	19	—	—	—	1	?	18,413,
—	—	4	—	—	—	—	1	2,267,811	16,455, (1891-
—	—	2	2	—	—	1	—	?	4,030, (189
—	2	—	—	—	—	—	—	779,628	25,720, (189
—	—	1	4	—	—	1	—	382,321	23,580, (189

ed on Parliamentary Return No. 465 of 15th December, 1893. The fourth column contains ting value may be assigned.

From the man's Year Those marke Board of T turns.

al Expenditure on Seagoing Force, the Value of Seaborne Commerce (exclusive of Inte
Revenue of British Self-governing Colonies for the latest Year for which Informa

OLONIES.	Naval expenditure on seagoing force.‡	Year.	Value of sea-borne commerce, exclusive of inter-change with United Kingdom.(*m*)	Year.	Revenue. (*m*)	Year.
	£		£		£	
..... Canada	—	—	14,750,000 (*d*)	1891-92	7,586,686	1891-92
Newfoundland	—	—	2,082,986	1891	392,586	1892
Total..... £	—	—	16,832,986 (*b*)	—	7,979,142	—
..... Cape Colony.....	—	—	2,419,438	1892	4,495,344	1891-92
Natal..... ..	—	—	1,290,783	1892	1,392,455	1891-92
Total..... £	—	—	3,710,221 (*b*)	—	5,887,799	—
New South Wales....	109,169 (*l*)	1891	26,210,875 (*g*)	1892	10,501,104	1892
Victoria	84,025 (*l*)	1891-92	16,932,500	1892	6,963,292	1892-93
Queensland	25,269 (*l*)	1891-92	7,406,769 (*g*)	1892	3,445,943	1892-93
..... South Australia.....	22,996 (*l*)	1891-92	9,950,865 (*g*)	1892	2,538,995	1892
Western Australia....	1,722 (*l*)	1891	1,285,061	1892	543,888	1892
New Zealand.....	20,489 (*l*)	1891-92	4,226,920	1892	4,389,251	1892
Tasmania	4,932 (*l*)	1891	1,986,671	1892	787,764	1892
Total..... £	268,602 (*l*)	—	67,999,661 (*b*)	—	29,170,237	—
Grand Total..... £	268,602 (*l*)	—	88,542,868 (*b*)	—	43,037,178	—

[*To face page* 1144.

onnage of Mercantile Marine, and Value of Seaborne Commerce of various
ilable.

gregate revenue.	Aggregate tonnage, mercantile marine (vessels of 100 tons gross and upwards).	Value of seaborne commerce.	Remarks.
£ 0,395,377* (1892–93)	Tons. 11,563,997 (1893–94)	£ 681,826,448 (1893)	(*a*) Figures show tens of rupees. The official rate of exchange for 1891–92 was 1*s.* 6$\frac{1}{2}$*d.*; for 1892–93 it was 1*s.* 4$\frac{3}{4}$*d.*
9,143,283* (*a*) (1891–92)	42,016 (net) † (1892)	103,263,941 (*a*) (*b*) (1891–92)	(*b*) Excluding trade with the United Kingdom, and necessarily counting inter-colonial trade twice over.
3,037,178* 1891–92–93)	1,059,071 (net) † (1892)	88,542,868 (*b*) (1891–92)	(*c*) Total trade.
6,116,658* (1891–92)	113,585 (net) † (1892)	55,406,000 (*b*) (*k*) (1891–92)	(*d*) Approximate only, the Returns making no distinction between seaborne and overland traffic.
8,692,496	12,778,669	929,039,257	(*e*) Estimated normal revenue.
4,560,000 (1891)	1,052,022 (1893–94)	271,972,000 (1892)	(*f*) Does not include vessels engaged in Lake trade.
3,467,000* (1891)	492,202 (1893–94)	64,142,000 (1891)	(*g*) Includes border trade.
2,661,000* (1890–91)	1,735,683 (1893–94)	211,402,000 (1890)	(*h*) Includes Her Majesty's vessels for the protection of floating trade in Australasian waters.
9,319,000* (1891–92)	796,247 (1893–94)	46,293,000 (1891)	(*i*) Includes Her Majesty's ships and vessels for the naval defence of India.
,179,000 (1891–92)	564,404 (1893–94)	64,636,000 (1891)	(*k*) There are no Returns for Hong Kong and Gibraltar. The trade of Hong Kong with countries other than the United Kingdom is estimated at upwards of £40,000,000.
7,981,000 (1891)	298,674 (1893–94)	22,850,000 (1890)	(*l*) From the "Victorian Year Book, 1892."
9,970,000 (1892)	442,071 (1893–94)	65,044,000 (1891)	(*m*) All figures for the commerce and revenue of the Colonies are from Board of Trade Returns.
,513,000 (1892–93)	104,394 (1893–94)	14,186,000 (*d*) (1890)	(*n*) Of this total, £15,330,857 was ordinary expenditure; £2,065,900 was expenditure under the Naval Defence Fund (outside Navy votes), and £5,985 expenditure under the Imperial Defence Fund.
,417,000* (1891–92)	1,005,950 (net) † (1890–91) (*f*)	373,256,000 (1890–91)	(*o*) Includes a contribution of £50,000 for Her Majesty's ships in Indian waters (this arrangement is still under consideration), and £50,000 on account for Her Majesty's ships and vessels for the Naval Defence of India. The amount to be paid under the last head will in future be £59,600 annually. The balance of Rx. 195,153 represents expenditure on the Royal Indian Marine.
,413,000 (*e*)	48,129 (1893–94)	58,000,000 (*d*) (1891)	
,455,000 (1891–92)	173,283 (1893–94)	23,742,000 (1891)	
,030,000 (1892)	108,626 (1893–94)	28,392,000 (*c*) (1890)	
,720,000 (1891)	196,981 (1893–94)	65,016,000 (*c*) (1890)	
,580,000 (1892)	54,454 (1893–94)	46,067,000 (1890)	
m the "States- Year Book." marked * from of Trade Re-	From Lloyd's Universal Register. Those marked † from Board of Trade Returns.	From Board of Trade Returns. Figures for Brazil from the "Statesman's Year Book."	

Interchange with the United Kingdom), and the
ormation is available.

Year.	Remarks.
891–92 1892	‡ The annual Australasian contribution of £126,000 for Her Majesty's vessels for the defence of floating trade in Australasian waters is included in these figures, the distribution being as follows:—
—	£ New South Wales ..... 37,656 Victoria ..... 37,414 Queensland ..... 13,260 South Australia ..... 10,527 Western Australia ..... 1,722 New Zealand ..... 20,489 Tasmania 4,932 £126,000
891–92 891–92	
—	
1892 892–93 892–93 1892 1892 1892 1892	
—	
—	